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CONTENTS

5 February 1996

SCIENCE AND TECHNOLOGY POLICY

Russia: Decisions of RAS Presidium (May-June 1995) [<i>Moscow VESTNIK ROSSIYSKOY AKADEMII NAUK No 10, Oct 95</i>]	1
Russia, West Cooperation in Science, Technology [<i>M. Astreina, Ye. Lenchuk; Moscow VESTNIK ROSSIYSKOY AKADEMII NAUK No 10, Oct 95</i>]	4
Russia: Ministry of Science Reports on Results of State S&T Funding [<i>A. Fedorova; Moscow POISK in Russian No 49, 2-8 Dec 95</i>]	9
Russian Federation Basic Research Fund Reports 1995 Distributions [<i>N. Borodina; Moscow POISK in Russian No 49, 2-8 Dec 95</i>]	10
Russia: Scientific Publishing Still at Low Point [<i>I. Goryunov; Moscow POISK in Russian No 49, 2-8 Dec 95</i>]	11

SPACE SCIENCE AND ENGINEERING

Russia: Modeling of Small-Scale Influence of High-Altitude Aircraft Engine Exhaust on Atmospheric Composition [<i>I. Karol, Yu. Ozolin; Moscow FIZIKA ATMOSFERY I OKEANA Vol 31 No 4, Jul-Aug 95</i>]	13
Russia: Charged-Particle Accelerators of 'Troll' Type as Feasible Space Research Tools [<i>V. Panasyuk; Moscow KOSMICHESKIYE ISSLEDOVANIYA Vol 33 No 5, Sep-Oct 95</i>]	13
Russia: Determining Dynamic Parameters of Space Vehicle From Results of Optical Measurements [<i>V. Borodin, O. Kayumov, et al.; Moscow KOSMICHESKIYE ISSLEDOVANIYA Vol 33 No 5, Sep-Oct 95</i>]	14
Russia: Optimum Control of Spatial Turn of Spacecraft [<i>M. Levskiy; Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 33 No 5, Sep-Oct 95</i>]	14
Russia: Constructing Region of Spacecraft Maneuvering During Atmospheric Entry at Quasicircular Velocity and Large Entry Angle [<i>R. Khayrullin; Moscow KOSMICHESKIYE ISSLEDOVANIYA Vol 33 No 5, Sep-Oct 95</i>]	14
Russia: Optimum Trajectories for Return of Spacecraft With Jet Engines of Great Limited Thrust From Moon to Earth [<i>K. Grigoryev, I. Grigoryev; Moscow KOSMICHESKIYE ISSLEDOVANIYA Vol 33 No 5, Sep-Oct 95</i>]	15
Russia: Robust Method for Reconstructing Descent Trajectory of Small Planetary Station Onto Martian Surface [<i>P. Ivankov; Moscow KOSMICHESKIYE ISSLEDOVANIYA Vol 33 No 5, Sep-Oct 95</i>]	15
Russia: Flexible Controllable Spacecraft With Perturbations From Internal Sources [<i>Ye. Malakhovskiy, E. Poznyak, et al.; Moscow KOSMICHESKIYE ISSLEDOVANIYA Vol 33 No 5, Sep-Oct 95</i>]	16
Russia: Natural Gas Pushed as Alternative, Less Expensive Fuel [<i>I. Dunyashina; Yekaterinburg OBLASTNAYA GAZETA 4 Oct 95</i>]	16

PHYSICS

Russia: Critical Current Density in Rail Guns with Composite Electrodes [<i>S. Stankevich, G. Shvetsov; Novosibirsk PRIKLADNAYA MEKHANIKA I TEKHNICHESKAYA FIZIKA No 3, May-Jun 95</i>]	17
Russia: Magnetic Accumulation Generators. Selection of Optimal Experimental Conditions [<i>A. Trubachev; Novosibirsk PRIKLADNAYA MEKHANIKA I TEKHNICHESKAYA FIZIKA No 3, May-Jun 95</i>]	17
Russia: Development of Disturbances at the Interface of Two Gases Accelerated by a Shock Wave [<i>S. Bakhrakh, B. Klopov, et al.; Novosibirsk PRIKLADNAYA MEKHANIKA I TEKHNICHESKAYA FIZIKA No 3, May-Jun 95</i>]	17
Russia: Effective Method of Calculating the Wave Resistance of Bodies of Revolution with a Transonic Range of Velocities [<i>M. Nayda, A. Fonarev; Novosibirsk PRIKLADNAYA MEKHANIKA I TEKHNICHESKAYA FIZIKA No 3, May-Jun 95</i>]	18
Russia: Effect of Heating on the Split-Off Destruction of Composites made of SKTN Rubber [<i>V. Golubev, G. Korshunova, et al.; Novosibirsk PRIKLADNAYA MEKHANIKA I TEKHNICHESKAYA FIZIKA No 3, May-Jun 95</i>]	18
Russia: Photoresistive Effect in Tunneling Transitions in δ -Doped GaAs/Metal [<i>I. Kotelnikov, A. Shulman, et al.; Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI Vol 62, Nos 1-2, 10-25 Jul 95</i>]	18

- Russia: Nonlinear Evolution of Ultrastrong Laser Pulses in a Plasma. New Effects of Magnetic Interaction Between Strong Beams of Electromagnetic Radiation [G. Askaryan, S. Bulanov, et al.; *Moscow FIZIKA PLAZMY* No 10, Oct 95] 38
- Russia: Modeling the Deposition of Diamond Films in a DC Discharge Reactor [Yu. Manelevich, A. Rakhimov, et al.; *Moscow FIZIKA PLAZMY* No 10, Oct 95] 39
- Russia: Competition of Antiferromagnetism and Superconductivity in $R\text{Ba}_2\text{Cu}_3\text{O}_{7-x}$ ($R = \text{Lu}, \text{Tm}$) [A. Lavrov, L. Kozeyeva; *Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI* Vol 62 No 7-8, 10 Oct 95] 39
- Russia: Compressibility of Iron, Aluminum, Molybdenum, Titanium, and Tantalum at Shock Wave Pressures of 1-2.5 TPa [R. Trunin, N. Panov, et al.; *Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI* Vol 62 No 7-8, 10 Oct 95] 39
- Russia: Quasi-Threshold Character of Absorption of Far IR Light in GaSb/InAs/GaSb Quantum Wells [A. Dmitriyev, S. Yemelyanov, et al.; *Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI* Vol 62 No 7-8, 25 Oct 95] 43

CHEMISTRY

- Russia: A Study of the Relationship Between Structure and Effect in a Series of Aminostigmine Derivatives [V. Prozorovskiy, L. Pavlova, et al.; *St. Petersburg ZHURNAL PRIKLADNOY KHIMII* Vol 67 No 12, Dec 94] 44
- Ukraine: Synthesis and Properties of Self-Binding Microflake Graphite [A. Melezhik, R. Rudy, et al.; *St. Petersburg ZHURNAL PRIKLADNOY KHIMII* Vol 68 No 1, Jan 95] 44
- Ukraine: Microflake Graphite-Based Electrode Materials [A. Melezhik, K. Gulyanitskiy, et al.; *St. Petersburg ZHURNAL PRIKLADNOY KHIMII* Vol 68 No 1, Jan 95] 45
- Ukraine: Electrical Conductivity of Microflake Graphite-Filled Composites [A. Melezhik, I. Monakhova; *St. Petersburg ZHURNAL PRIKLADNOY KHIMII* Vol 68 No 1, Jan 95] 46
- Ukraine: Direct Thermal Oxidative Conversion of Graphite Into Foam Graphite—The Road to New Technologies [A. Yaroshenko, M. Savoskin; *St. Petersburg ZHURNAL PRIKLADNOY KHIMII* Vol 68 No 1, Jan 95] 46
- Russia: Group and Individual Chromatographic Identification of Organic Compounds in Multisection Columns [M. Vigdergauz, Ye. Revinskaya, et al.; *Moscow KHIMIYA I KHIMICHESKAYA TEKHOLOGIYA* Vol 38 No 1-2, Jan-Feb 95] 47
- Estonia: Electrochemical Studies of Oxygen, Hydrogen Peroxide, and Superoxide Anion on Thin Metal Films for the Development of Amperometric Sensors [K. Tammeveski, T. Tenno; *Tallinn PROCEEDINGS OF THE ESTONIAN ACADEMY OF SCIENCES. CHEMISTRY* Vol 44 No 2-3, Feb-Mar 95] 47
- Estonia: Stability of a Phenol-Sensitive Microbial Sensor [K. Orupold, T. Tenno; *Tallinn PROCEEDINGS OF THE ESTONIAN ACADEMY OF SCIENCES. CHEMISTRY* Vol 44 No 2-3, Feb-Mar 95] 48
- Estonia: Possibilities of Biodegradation of Phenol-Containing Wastes Originating From the Oil Shale Basin in Northeastern Estonia [T. Randla, A. Rozkov, et al.; *Tallinn PROCEEDINGS OF THE ESTONIAN ACADEMY OF SCIENCES. CHEMISTRY* Vol 44 No 2-3, Feb-Mar 95] 48
- Russia: Study of Properties of Ceramic and Sensors Based on Modified Indium Oxide [N. Trofimenko, S. Baran, et al.; *St. Petersburg ZHURNAL PRIKLADNOY KHIMII* Vol 68 No 3, Mar 95] 49
- Russia: Photo- and Electrochemical Properties of Partially Oxidized Polymer Complex of Cobalt With Bis(salicylidene)ethylenediamine [I. Orlova, A. Timonov, et al.; *St. Petersburg ZHURNAL PRIKLADNOY KHIMII* Vol 68 No 3, Mar 95] 50
- Russia: Developing a Method of Obtaining New Nutrient Solutions for Growing Microorganisms [A. Stepchenko; *Moscow KHIMICHESKAYA PROMYSHLENNOST* No 4, Apr 95] 50
- Russia: Sonochemical Synthesis of Coordination Compounds of Hydrazonopodands With CuSO_4 [O. Fedorova, I. Ovchinnikova, et al.; *St. Petersburg ZHURNAL OBSHCHEY KHIMII* Vol 65 No 4, Apr 95] 51
- Russia: Superoxide Dismutase Activity of Stable Nitroxyl Radicals [I. Shugaley, I. Tselinskiy, et al.; *St. Petersburg ZHURNAL OBSHCHEY KHIMII* Vol 65 No 4, Apr 95] 51
- Russia: Photosensitive Polymers Based on Complex Compounds of Copper (II) and Palladium (II) With Bis(salicylidene)ethylenediamine [G. Shagisultanova, I. Orlova, et al.; *St. Petersburg ZHURNAL PRIKLADNOY KHIMII* Vol 68 No 4, Apr 95] 52
- Russia: Immobilized Cholinesterase-Based Amperometric Biochemical Sensor in Immunoassay of Pesticides [E. Medyantseva, M. Vertlib, et al.; *Moscow ZHURNAL ANALITICHESKOY KHIMII* Vol 50 No 7, Jul 95] 52
- Russia: Thermodynamics of Reactions of Coproportionation of Like Solvates of Samarium (III) and Yttrium (III) Nitrates With Neutral Organophosphorus Compounds [A. Pyartman; *St. Petersburg RADIOKHIMIYA* Vol 37 No 4, Jul-Aug 95] 53

Russia: Coprecipitation of ^{152}Eu With Ferric Hydroxide Formed During the Reduction of Sodium Ferrate (VI) in an Aqueous Medium [D. Stupin, M. Ozeroy; St. Petersburg <i>RADIOKHIMIYA</i> Vol 37 No 4, Jul-Aug 95]	54
Russia: New Approach to Synthesizing Immobilized Stationary Phases for Capillary Gas Chromatography [V. Mukhina, Ya. Levin, et al.; Moscow <i>ZHURNAL ANALITICHESKOY KHIMII</i> Vol 50 No 9, Sep 95]	54
Russia: Rapid Immunochemical Method of Detecting the Herbicide Methabenzthiazuron [S. Yeremin, O. Melnichenko, et al.; Moscow <i>ZHURNAL ANALITICHESKOY KHIMII</i> Vol 50 No 9, Sep 95]	55
Russia: Altering Selectivity of Potentiometric Analysis Methods [B. Nikolskiy, Ye. Nikolskaya; Moscow <i>ZHURNAL ANALITICHESKOY KHIMII</i> Vol 50 No 9, Sep 95]	55
Russia: Magnetothermoelectric Properties of Extruded Samples of Lead-Alloyed Solid Solution of $\text{Bi}_{15}\text{Sb}_{15}$ [M. Tagiyev, D. Abidinov; Moscow <i>NEORGANICHESKIYE MATERIALY</i> Vol 31 No 11, Nov 95]	56
Russia: Structure and Magnetic Properties of Quick-Hardening Foil of the System Mn-Bi [V. Vlasov, S. Gusakova, et al.; Moscow <i>NEORGANICHESKIYE MATERIALY</i> Vol 31 No 11, Nov 95]	57
Russia: Physicochemical Properties of $(\text{Bi}_{1-x}\text{Pb}_x)_2\text{Y}_2\text{O}_7$ ($y = 0$ to 0.25 and $x = 0.10$ and 0.32) Ionic Conductors [Ye. Naumovich, V. Kharton, et al.; Moscow <i>NEORGANICHESKIYE MATERIALY</i> Vol 31 No 11, Nov 95]	57
Russia: Magnetite Colloid With High Magnetic Susceptibility [A. Pshenichnikov, A. Lebedev; Moscow <i>KOLLOIDNYY ZHURNAL</i> Vol 57 No 6, Nov-Dec 95]	58
Russia: Laser Scanning Polarimeter-Based Computer Phase Microscope [M. Valeyko, R. Kononov, et al.; Moscow <i>KOLLOIDNYY ZHURNAL</i> Vol 57 No 6, Nov-Dec 95]	59
Russia: Structural, Selective Properties of a New Type of Porous Media—Punch-Track Membranes and Filters [A. Yevdokimov, A. Kirillov, et al.; Moscow <i>KOLLOIDNYY ZHURNAL</i> Vol 57 No 6, Nov-Dec 95]	60

EARTH SCIENCES

Russia: Calculated Model of Global Carbon Circulation [K. Demirchyan, K. Demirchyan; Moscow <i>ENERGETIKA</i> No 5, Sep-Oct 95]	61
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**Russia: Decisions of RAS Presidium
(May-June 1995)**

964D0151A Moscow VESTNIK ROSSIYSKOY
AKADEMII NAUK in Russian Oct 95
No 10, pp 950-953

[Unsigned article]

[FBIS Translated Text] The Russian Academy of Sciences (RAS) Presidium has made the following decisions.

The Administration of Planning and Capital Construction RAS is instructed over a three-month period to re-examine the list of facilities being constructed by means of centralized capital investments for institutions of the Russian Academy of Sciences and its regional departments and during the drawing up of the budget for 1996, present, in the established order, to the government of the Russian Federation proposals on the concentration of investment resources on the completion of construction of facilities which have not lost their timeliness and which are to be put into operation during 1996-1997.

The Financial-Economic Administration RAS is delegated the task of drawing up proposals for a draft resolution of the RF government on the organization of work on the introduction of a federal contractual system for the funding of scientific-technical projects from budgeted sources, as well as funds from outside the budget. The Financial-Economic Administration RAS, together with the Personnel Department RAS, must work out proposals for improving the system for paying the wages of highly qualified scientists and specialists in the scientific and technical sphere. The Financial-Economic Administration RAS, Science Organization Administration RAS, Foreign Relations Administration RAS, Akademintorg Joint-Stock Company and Marine Expeditions Center RAS, acting jointly, must present proposals on the allocation of foreign exchange for the patenting and support of advancement of Russian technologic development work abroad; on the payoff of indebtedness and payment of 1995 dues to international scientific organizations, as well as for the purchase of scientific and polygraphic equipment, office equipment, materials and reagents, foreign scientific journals, support of sea expeditions and repair of scientific research ships.

The attention of the academician-secretaries of the Department of Problems in Machine Building, Mechanics and Control Processes, Department of General Biology, Department of Geology, Geophysics, Geochemistry and Mining Sciences and Economics Department RAS is drawn to the illegality of decisions to extend the exercise of authority of individual directors of RAS scientific institutions without announcement of a competition.

E. S. Gorkunov, doctor of technical sciences, director of the Machine Sciences Institute, Ural Department RAS, is approved as a member of the Presidium, Ural Department RAS.

Academician N. A. Kuznetsov and V. K. Levin, corresponding member RAS, are approved as board members of the Department of Information Science, Computers and Automation RAS.

Academician A. D. Mirzabekov is freed from his obligations as deputy academician-secretary of the Department of Physicochemical Biology RAS in conformity to his personal request. Appreciation was expressed to A. D. Mirzabekov for his work in this post.

Academician V. T. Ivanov is approved as deputy academician-secretary of the Department of Physicochemical Biology RAS, having been elected to this post by a general meeting of the department.

Academician Yu. V. Natochin is approved as deputy academician-secretary of the Physiology Department RAS, having been elected to this post by a general meeting of the department.

A. G. Zakharov, candidate of technical sciences, is designated to perform the tasks of director of the Natural Sciences Library RAS for a period of two years.

Academician E. M. Galimov, G. V. Kozlov, doctor of physical and mathematical sciences, RF Deputy Minister of Science and Technical Policy, and N. I. Komkov (National Economy Prediction Institute RAS) are appointed board members of the RAS Space Council.

I. M. Bortnik (RF Ministry of Science and Technical Policy) and V. S. Vereshchetin (State and Law Institute RAS) are relieved as members of the RAS Space Council.

V. L. Talroze, corresponding member RAS, is designated counsellor of the Russian Academy of Sciences.

Academician S. N. Bagayev and O. N. Krokhin, corresponding member RAS, are approved as members of the board of the General Physics and Astronomy Department RAS.

K. F. Shatsillo, doctor of historical sciences, is freed from his obligations as chief editor of the journal OTECHESTVENNAYA ISTORIYA RAS (National History RAS) at his personal request. Appreciation was expressed to K. F. Shatsillo for his many years of productive work in this post.

S. V. Tyutyukin (Russian History Institute RAS), doctor of historical sciences, is approved as chief editor of the journal OTECHESTVENNAYA ISTORIYA RAS.

L. L. Grodnitskiy, doctor of geological and mineralogical sciences, is freed from his obligations as a member of the Presidium of the Karelian Science Center RAS at his personal request.

V. Ya. Gorkovets, doctor of geological and mineralogical sciences (Geology Institute, Karelian Science Center RAS), is approved as a member of the Presidium of the Karelian Science Center RAS.

Yu. G. Leonov, corresponding member RAS, is approved as deputy academician-secretary of the Department of Geology, Geophysics, Geochemistry and Mining Sciences RAS, having been elected to this post by a general meeting of the department.

Academician A. M. Kutepov is approved as chief editor of the journal VYSOKOCHISTYYE VESHCHESTVA RAS (Ultrapure Substances RAS).

Academician G. A. Arbatov is designated counsellor of the Russian Academy of Sciences.

The Organic Chemistry Institute imeni N. D. Zelinskiy RAS is authorized to expend from its own accounts up to 1.5 million rubles [R] on the designing, preparation and placement of a tombstone on the grave of A. M. Moiseyenko, corresponding member RAS, buried in the Troyekurovskoye Cemetery (Moscow), as well as up to R500 thousand on the designing, preparation and placement of a memorial tablet in the hall of the main building of the Organic Chemistry Institute imeni N. D. Zelinskiy RAS with the following text: "Aleksandr Makarovich Moiseyenko, corresponding member RAS, outstanding organic chemist, worked at this institute from 1960 through 1992."

The Oceanology Institute imeni P. P. Shirshov RAS is authorized to expend from its own accounts up to R1.5 million on the designing, preparation and placement of a tombstone on the grave of V. G. Kort, corresponding member RAS, buried in the Troyekurovskoye Cemetery (Moscow).

The Oceanology Institute imeni P. P. Shirshov RAS is authorized to expend from its own accounts up to R1.5 million on the designing, preparation and placement of a tombstone on the grave of Academician S. L. Solov'yev, buried in the Donskoy sector of the Nikolo-Arkhangelskiy Affiliate (Moscow).

The Geological Engineering and Geologic Science Center RAS is authorized to expend from its own accounts up to R1.5 million on the designing, preparation and placement of a tombstone on the grave of P. F. Shvetsov, corresponding member RAS, buried in the Troyekurovskoye Cemetery (Moscow). The Scientific Publishing Council RAS is delegated the task of ex-

amining the proposals of the Department of Oceanology, Atmospheric Physics and Geography RAS with respect to publication of the brochure entitled "Petr Filimonovich Shvetsov" in the series *Materialy k biobibliografii uchenykh RAN* (Materials for a Biobibliography of RAS Scientists).

The Petrochemical Synthesis Institute imeni A. V. Topchiyev RAS is authorized to expend from its own accounts up to R1.5 million on the designing, preparation and placement of a tombstone on the grave of Academician B. A. Dolgoplosk, buried in the cemetery of the Donskoy Crematorium (Moscow), as well as up to R500 thousand on the designing, preparation and installation of a memorial plaque within the building of the Petrochemical Synthesis Institute imeni A. V. Topchiyev RAS with the following text: "The outstanding scientist Academician Boris Aleksandrovich Dolgoplosk worked in this building from 1963 through 1994." The Scientific Publication Council RAS is instructed to examine the proposals of the Department of General and Technical Chemistry RAS with respect to publication of the book entitled "Boris Aleksandrovich Dolgoplosk" in the series *Materialy k biobibliografii uchenykh RAN*.

The Scientific Publication Council RAS is instructed to examine the proposals of the Department of Geology, Geophysics, Geochemistry and Mining Sciences RAS on publication of a volume of the selected works of Academician V. V. Rzhnevskiy, as well as the brochures "Vladimir Vasilyevich Rzhnevskiy," in the series *Materialy k biobibliografii uchenykh RAN*.

The Joint Earth Physics Institute imeni O. Yu. Shmidt RAS is authorized to expend from its own accounts up to R1.5 million on the designing, preparation and placement of a tombstone on the grave of Academician M. A. Sadovskiy, buried in the Troyekurovskoye Cemetery (Moscow). The Scientific Publication Council RAS is instructed to examine the proposals of the Department of Geology, Geophysics, Geochemistry and Mining Sciences RAS with respect to publication of a volume of selected works of Academician M. A. Sadovskiy at the expense of the Joint Earth Physics Institute imeni O. Yu. Shmidt RAS.

The Oceanology Institute imeni P. P. Shirshov RAS is authorized to expend from its own accounts up to R1.5 million on the designing, preparation and placement of a tombstone on the grave of L. P. Zonenshaya, corresponding member RAS on the grounds of the Donskoy Crematorium (Moscow), as well as up to R500 thousand on the designing, preparation and placement of a memorial plaque within the building of the Oceanology Institute imeni P. P. Shirshov RAS with the following text: "Professor Lev Pavlovich Zonenshaya, doctor

of geological and mineralogical sciences, corresponding member RAS, well-known geologist, expert in the tectonics field, worked at the Oceanology Institute imeni P. P. Shirshov RAS from 1974 through 1992."

It is recommended that the candidacy of Academician N. A. Plate be put forward for award of the UNESCO Science Prize for 1995.

The Business Administration and Personnel Section RAS are called upon to analyze the situation prevailing with RAS housing accommodations and to draw up proposals on this matter for discussion at a session of the RAS Presidium.

The Personnel Section and the Foreign Relations Administration RAS are delegated the task of drawing up proposals with respect to the affording of residential quarters for graduate students and probationers from near abroad for subsequent discussion at a session of the RAS Presidium.

The academician-secretaries of the RAS departments are called upon to prepare a more precise list of the tasks of department specialists, bearing in mind that the salary increment for an academic degree in the central offices of the departments must be received only by individuals performing scientific tasks.

V. P. Leonov, doctor of pedagogic sciences, is selected as the director of the Russian Academy of Sciences Library.

There must be considerable revision of the draft of the "National Science Doctrine," drawn up at the RF Ministry of Science and Technical Policy (Minnauka) and presented for examination by the Russian Academy of Sciences. The RF Minnauka will be sent a full summary of the comments and supplements to this project received from RAS specialized and regional departments and RAS regional science centers, as well as a transcript of the discussion held on this subject.

A list of priority directions in the development of basic research and critical technologies at the federal level, prepared by RAS departments, is adopted for information purposes. Academician N. P. Laverov, RAS vice president, is instructed to organize the preparation of summarized proposals from the Russian Academy of Sciences on priority directions in the development of basic research and critical technologies at the federal level.

The Charter of the Kola Science Center of the Russian Academy of Sciences is approved.

The Presidium of the Kola Science Center is approved with the following makeup: V. T. Kalinnikov, corresponding member RAS (chairman), G. V. Kalabin,

doctor of technical sciences (deputy chairman), I. A. Kuzmin, candidate of physical and mathematical sciences (deputy chairman), V. P. Petrov, candidate of geological and mineralogical sciences (deputy chairman), A. N. Vinogradov, candidate of geological and mineralogical sciences (chief scientific secretary), G. N. Andreyev, candidate of biological sciences, V. R. Yelokhin, doctor of technical sciences, G. P. Luzin, doctor of economic sciences, G. G. Matishov, doctor of geographical sciences, N. N. Melnikov, doctor of technical sciences, F. P. Mitrofanov, doctor of geological and mineralogical sciences, V. A. Putilov, doctor of technical sciences, and Ye. D. Tereshchenko, doctor of physical and mathematical sciences.

The following, elected by the general meeting of the St. Petersburg Science Center RAS, are approved: Academician A. A. Fursenko — deputy chairman of the center presidium; Academician B. V. Ananich, N. I. Komyak, doctor of technical sciences, and Academician A. D. Sheglov — members of the center presidium.

Sh. O. Abdullayev, candidate of technical sciences, is approved as chief scientific secretary of the Dagestan Science Center (DSC) RAS Presidium; A. M. Amadziyev, candidate of physical and mathematical sciences, member of the DSC RAS presidium, is approved as director of the Joint Scientific Research and Production Center DSC and the IVTAN Science Association RAS.

The following are relieved as presidium members of the Dagestan Science center RAS: A. M. Vagidov, doctor of philological sciences, G. M. Gaydarov, candidate of geological and mineralogical sciences, Academician M. Ch. Zalikhanov, A. T. Mammayev, candidate of biological sciences, Yu. A. Polyakov, corresponding member RAS, and M. Sh. Shikhsaidov, candidate of physical and mathematical sciences.

The draft of a joint resolution of the science council of Moscow State University imeni M. V. Lomonosov and the Presidium of the Russian Academy of Sciences on the organization of a Soil Science Institute at Moscow State University imeni M. V. Lomonosov and in the Russian Academy of Sciences is approved. The overall scientific and scientific-methodological direction of the new institute is imposed: with respect to Moscow State University — on the scientific council of the soil science faculty, with respect to the RAS — on the General Biology Department.

The following principal directions in the scientific and scientific-organizational activity of the Soil Science Institute, Moscow State University and the RAS, are approved:

— conducting basic research on the priority aspects of soil science and related scientific branches, participation in world scientific research for the purpose of development of human civilization and preservation of the environment;

— assurance of integration of scientific research carried out in the field of soil science and related sciences at Moscow State University imeni M. V. Lomonosov (MGU) and by subdivisions of the Russian Academy of Sciences;

— improvement in the forms of organization and implementation of scientific research in such priority fields as soil genesis, morphology and systematization, geography and ecologic functions of soils, soil physics, soil chemistry and soil biology.

The funding of the Soil Science Institute of Moscow State University and the RAS will be accomplished for the most part from sums allocated on parity purposeful use principles by the scientific council of Moscow State University imeni M. V. Lomonosov and the RAS Presidium. Academician G. V. Dobrovolskiy is designated director-organizer of the Soil Science Institute MGU and RAS.

Consent is given to the proposal of the Department of Physical and Technical Power Production Problems RAS on the organization in the department of a Scientific Council RAS on the Problems Involved in Reliability and Safety of Large Power Production Systems.

Academician V. A. Vinogradov is designated to fill the office of director of the Institute of Scientific Information for the Social Sciences RAS for a period of two years.

A. T. Mikhaylov, doctor of biological sciences, is freed from his obligations as chief editor of the journal *ONTOGENEZ RAS* (Ontogenesis RAS) at his personal request. Appreciation was expressed to A. T. Mikhaylov for his productive work in this post.

S. G. Vasetskiy, doctor of biological sciences, is appointed chief editor of the journal *ONTOGENEZ RAS*.

Academician Yu. V. Natchin is approved as chief editor of the *FIZIOLOGICHESKIY ZHURNAL im. I. M. SECHENOV RAS*.

An RAS Scientific Council on Politology Problems is to be established under the RAS Presidium. The regulations for the RAS Scientific Council on Politology Problems and the makeup of this council, headed by F. M. Burlatskiy, doctor of philosophical sciences, were approved.

Academician Ye. S. Fradkin is appointed counsellor of the Russian Academy of Sciences.

The proposals of the Russian Academy of Sciences on the matter of ratification of the Environmental Protection Protocol to the Antarctic Treaty are approved. Among these proposals is a recommendation to the government of Russia that it adopt a resolution or other juridical act regulating, in particular, the procedure for obtaining permission for presence and all types of activity in Antarctica for Russian organizations and private individuals. The RAS also proposes that the protocol be supplemented by a paragraph providing for international cooperation (for example, a consortium) with a financial contribution from all countries signing the Antarctic Protocol on the cleanup of ecologically unfavorable Antarctic regions and the development and introduction of ecologically clean technologies. The proposals of the Russian Academy of Sciences are directed to the government of the Russian Federation.

The Commission on the Program for Purposeful Support of the Instrument Base of RAS Experimentally Oriented Institutes, headed by Academician A. F. Andreyev, is approved.

The Commission on the Program "Scientific Expeditions and Station Facilities," headed by Academician N. P. Laverov, is approved.

Communications of the academician-secretaries of the RAS departments on the network of scientific institutions of the departments, presented at an RAS Presidium session, are received for information purposes. The academician-secretaries of the RAS departments and chairmen of RAS regional departments and science centers prior to 15 September 1995 must present to the RAS Presidium refined proposals for the improvement of the RAS network of scientific institutions, departments and science centers, as well as systems for the distribution of basic funding in the Russian Academy of Sciences at the level of departments and scientific institutions. The RAS vice presidents must generalize the results of work on improving the network of scientific institutions, the RAS departments which they head and the scientific institutions operating under the RAS Presidium and report on them at a Presidium session.

Russia, West Cooperation in Science, Technology
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AKADEMII NAUK in Russian Oct 95
No 10, pp 886-890

[Article by M. K. Astreina and Ye. B. Lenchuk, candidates of economic sciences, scientific specialists, Institute of International Economic and Political Research,

Russian Academy of Sciences; the first paragraph is an abstract]

[FBIS Translated Text] *The authors of the article feel that the ideology of cooperation in the field of science and technology between Russia and the West requires reexamination. There is a need for new forms of mutually advantageous partnership which would not make our country dependent on foreign donors.*

In the overall volume of scientific and technical relationships between the Western countries and the former union republics the RF accounts for about 80 percent. The striving to activate cooperation with Russia is attributable to a number of factors. Among them, in addition to the fear that our specialists will participate in the development of the nuclear programs of Iran, Pakistan and Libya, an important place is occupied by the possibility of gaining access to the attainments of Russian scientists in the basic research field. Particular interest is being shown in the scientific research and experimental design work in the sphere of the military-industrial complex, especially in cosmonautics, aircraft and rocket building, where Russia has been traditionally strong. A number of agreements have already been signed. The Boeing Corporation, for example, intends to establish a scientific research center for aviation technology in Moscow Oblast and at the same time is planning to make use of Russian technologies. An agreement has been reached with foreign companies on the joint development of second-generation supersonic passenger aircraft. The European Space Agency has signed contracts with Russia for the sum of \$120 million providing for the training of West European astronauts and has transferred a considerable part of the research contracts under the Hermes flightcraft program to the Russian Space Center.

In addition, the attention of the West is being drawn to the advanced technologies of the military-industrial complex (MIC) which can be used in the civilian sector and the organization of joint enterprises in such promising high technology branches as image processing, software, aerial photographic surveying, materials (composition, heat-resistant alloys, armor plate), power plants, welding, superconductivity, vibrational processing and tests in wind and hydrodynamic tunnels.

With respect to scientific and technical partnership in the civilian branches of our economy, the well-developed countries are manifesting far less interest in that. Moreover, they are striving to preserve the appreciable lead in the development of innovations and technologies already existing in the 1980's between the West and the USSR. This to a great degree explains the complexities in the broadening of cooperation and

the making of investments, especially in the Russian machine building complex. The business interests of the leading Western countries are looking upon it primarily as a promising sales market for their own machine building products and do not intend to yield their leadership. It is the opinion of specialists that the impact of foreign investments on the export potential of Russian machine building during the next five-seven years will on the whole be insignificant.

The point of departure in interrelationships between Russia and the West, structured on new principles, was a political declaration on partnership and cooperation between the RF and the EU (European Union) signed on 9 December 1993. Within the scope of the signed agreements plans call for the broadening of relationships in industry, including the conversion of defense enterprises; organization of a favorable climate for local and foreign investments; development of cooperation in the field of power production, transportation and communication, as well as science, technology and education.

The exchange of specialists, scientific missions and advanced study abroad and learning and practical work in different state and private scientific institutions remains the traditional form of joint activity. The work of Russian specialists and scientists under contracts concluded with foreign companies and science centers has recently become common. The American Telephone and Telegraph (AT&T) Company, inviting specialists of the Theoretical Physics Institute imeni L. D. Landau RAS, became one of the first of such companies. These specialists are conducting research with a group of American colleagues working in the U. S. Bell Laboratories — an AT&T scientific subdivision. The total amount of the contract is estimated at several hundred thousand dollars, which includes monies for brief missions of Russian scientists to the United States. In addition, the U. S. Bell Laboratories have allocated money to the institute for buying equipment for implementing projects for developing the metal covering for optical fibers. An agreement also was reached on the rights to intellectual property. The Theoretical Physics Institute RAS is assigned patent rights for any results of research carried out within Russia, whereas the Bell Laboratories acquire the patent rights applicable to all remaining territories [1].

Our fellow countrymen, formerly employed in the defense industry, are working in a number of American companies. For example, Sun Microsystems invited a large group of specialists for work on supercomputers. Scientists of the Atomic Energy Institute imeni I. V. Kurchatov have been called upon to provide their assistance to American colleagues in constructing a thermonuclear reactor.

International scientific and technical projects are a promising form of cooperation between Russian scientists and foreign partners. During 1995 the administrations of the RF Ministry of Science and Technical Policy received applications for the funding of 456 projects, including for 85 newly formulated ones [2]. Scientific and technical contacts also are developing within the framework of multilateral joint programs, the number of which during recent years has increased by a minimum of 20 percent. At the same time there has been a considerable increase in the percentage of projects directed to seeing to it that the Western countries effectively assist the development of science and technology in the RF.

The total amount of foreign assistance is comparable to the amounts of national funding of Russian science (in 1993 — \$500 million and 848 billion rubles [R] respectively). At the present time the funding of international projects is being accomplished by the West primarily at the national and regional levels; this includes funding by different departments, universities, scientific research institutes and organizations, as well as private funds.

Among the latter the best known is the International Science Fund, established in December 1992, based on the financial resources of G. Soros. In contrast to many other programs directed for the most part to meeting the needs of the donors themselves, the objective of the fund is to afford practical support for basic research in the former republics of the USSR and it relinquishes intellectual property rights to the results obtained. The fund administrative board approved the recommendations of the expert councils on the awarding of grants in the first round of the competition of long-range projects for a total sum of \$32 million. In the course of this round, 2,116 grants were awarded (9,000 applications had been received), amounting to between \$5,000 and \$70,000. Within the framework of each grant, provision is made for support of scientific personnel, purchases of imported equipment and materials, payment for trips to international conferences, etc. The second round, in the course of which about \$13 million was distributed (about 1,000 applications were submitted), was completed in the autumn of 1994.

During 1993 the fund distributed \$13 million in the form of individual grants (each for \$500) among the scientists of all the former union republics, now independent states. Positive decisions were adopted on 25,436 of the 32,732 applications for immediate individual assistance. Most of the grants (about 80 percent) were awarded to Russian scientists; among the latter more than 57 percent work in academic institutes, 22 percent in branch institutes and 21 percent in institutions of higher education. The greatest number of \$500 grants was awarded to physicists (36.8 percent), biologists (25.1

percent) and chemists (23.8 percent). Three thousand scientists participated in scientific conferences abroad. More than 200 libraries received annual subscriptions to scientific journals valued at \$3 million [3].

Soros is ready to continue purposeful funding, including trips to conferences, subscriptions to scientific journals and development of a system for telecommunication among the scientific institutions of the former USSR and the Western countries, but for the time being is holding back from individual allocation of sums for long-term grants in their full amount. He has agreed to make \$12.5 million available under the condition that an equal contribution also be made by other parties. In this connection the RF government has made the decision to seek a sum equivalent to this \$12.5 million. It is planned that an additional \$25 million be obtained from other sources, which in general will provide additional resources for the realization of cooperation during the years immediately ahead.

An international association intended to assist in strengthening the bonds with scientists of the new independent states (INTAS) began its activity in mid-1993. The INTAS budget, generated primarily by the European Union, during 1993-1994 was 50 million ECU. These sums were directed to implementation of joint research projects of 18 countries — association members, selected on a competitive basis [4].

The principal amount of technical assistance for the CIS from the European Union (EU) is embodied in the TACIS (Technical Assistance for the Commonwealth of Independent States) Program, within whose scope projects are being carried out in the following fields: power production, food distribution, transportation, financial services, training of specialists, privatization, conversion and support of small and intermediate enterprises. In addition to national programs, regional inter-governmental programs affecting the common interests of a number of countries are being implemented. During the period 1991-1994 the partners were allocated, without cost to them, a total of 1,870 million ECU, which made it possible to proceed to the implementation of 2,000 projects, including in the science and technology sphere [5].

Russia has become a full-rights participant in the EU scientific-technical program "Copernicus." The objective of this program is to activate research in those fields of science and technology which will assist Central and Eastern European countries in more rapidly achieving progress in economic transformations. Five hundred projects have been proposed by Russian scientists.

The EU has set up the TEMPUS (Transeuropean System for Cooperation in Higher Education) program for supporting the further development and renewal of higher education in the CIS states. Within the scope of this program funding is being supplied for joint projects developed by institutions of higher education in Russia, Ukraine and Belarus, on the one hand, and the EU countries, on the other. Initially applications for participation in the program were received from 264 universities. After a selection process carried out by an expert council the right for subsidization was granted to 77 projects in such fields as management, linguistics, history, economics, jurisprudence, international relations, etc. During the preliminary stage partners from Western Europe and the CIS developed material and technical support for their projects and made familiarization trips. Later on the best projects will be admitted to a full cycle (three years) and will receive subsidies in an amount 1 million ECU [6].

An International Science and Technology Center, funded by the EU, Russia, United States and Japan, has been established in Moscow in order to prevent the brain drain. The interest of the West in what is seemingly "our" problem is attributable, as already noted, to the concern that highly qualified Russian specialists in the fields of nuclear and chemical weapons may be able to find work in Iran, Libya, Pakistan, etc. First an agreement was signed in 1992 on the financial support of unemployed scientific specialists earlier having jobs at military enterprises. The center has now registered more than 180 programs proposed by different institutes in Russia and other CIS countries, of which a total of 75 have been selected and presented for examination by special commissions. They provide for research in the field of nuclear safety, environmental protection, pharmaceuticals and laser technology. It is proposed that the EU and the United States will each contribute \$25 million for the operating expenses of the center. Japan will contribute \$17 million. The Russian side will supply the body of specialists, material and technical base and initial infrastructure. The total budget for the center will supposedly be \$100 million, but for the time being only an insignificant part of the promised sums has been received.

Western investors are actively supporting the implementation of the basic research in which Russian schools are traditionally strong. There are now about 80 agreements between the RAS and foreign academies and science centers. More than 30 intergovernmental agreements are being implemented and on the basis of direct relationships academic institutes are carrying out research under the provisions of 350 protocols. In 1992 an Association for Establishing an International Fund was organized

in the RAS which is to coordinate the efforts of the foreign community providing assistance in the development of basic research. The International (Brussels) Association, intended to facilitate cooperation with CIS scientists, also was established for this purpose in June 1993. This is a private independent organization whose makeup includes the 12 EU states, the European Community and Austria. The association allocates sums for special grants for projects in such fields as chemistry, physics, social sciences and environmental protection.

The implementation of the special EU TACIS program for the reorientation of military aerospace enterprises in Russia and their transformation into flourishing companies with a 100 percent workload began in 1994. In the first stage a group of 25 foreign and Russian specialists will work at the Moscow Hydrodynamics Institute and the Lukhovitskiy Plant in Moscow Oblast over the course of one or two years. The task of this group is to develop a suitable conversion strategy, ensure access to Western markets, introduce methods for monitoring the quality of products, draw up programs for cooperation with Western partners and study the possibilities of privatization.

It must be noted that many Western assistance programs intended for support of Russian scientific and technical capabilities are experiencing damage. The reasons frequently rest in the disagreements arising among the foreign partners, as well as in bureaucratic obstacles. For example, in 1992 the ISTC, mentioned above, is to distribute the total contribution of the EU countries, United States and Japan — \$71 million — in the form of grants for the support of science in the former Soviet Union [7]. However, due to the fact that the donor states for more than a year disputed project details, it was not easy to bring together its participants in order to ratify the agreement, much time was spent on translation of the corresponding text and the agreed-upon sum has not been delivered in full.

But that's just half the trouble. Far more harm is being inflicted by the failure to iron out the internal mechanism for affording assistance. Over the course of 10 months the ISTC was a "ball" kicked around in a political game; certain parties regarded it as demeaning to receive money for the development of nuclear science from foreigners.

The implementation of Western state and private programs also is meeting with other difficulties. In particular, in Russia (as in the remaining CIS countries) there is no adequate financial infrastructure for awarding grants. For example, the services of the Soros International Science Fund (ISF) required about a year in order to reach agreements between the Bank of New

York and Menatep which would enable the ISF to print name checks with pertinent data. In order for money to reach the hands of scientists the American Physics Society had to organize its own international banking network by means of special agreements between American banks and countries of the former USSR.

Despite the apparent positive role of Western assistance, directed to the preservation and further development of Russian scientific and technical capabilities, it carries within it the germs of further weakening of the technologic security of Russia. First of all, the very system for the collection of information on scientific development work, institutions and scientific research personnel when taking applications for obtaining grants and other aids from foreign organizations provides an exhaustive idea concerning the present status and problems in Russian science and technology. At times Russian government agencies do not have access to such a level of information.

As a result, information is collected on the most promising directions in research and the most qualified and productively working scientific personnel in order later on to use this information in one form or another in their own interests. By distracting a considerable part of the scientific and technical potential of Russia from solution of the problems facing it, foreign investors are establishing in our country their kind of branch servicing the needs of the Western economy. In addition, they have the possibility not only of bottling up, but even completely blocking individual directions in Russian science and technology, especially in those fields where attainments are competitive on the world market.

Meanwhile, in the United States, for example, more than 6,000 inventions are carefully controlled, which in the event of their use by other countries could threaten not only the technologic, but also the national security of the country. The holding back of information on advanced development work pursues the objective of reinforcing the definite time lead of the United States in the creation and exploitation of the latest technology.

It must be noted that due to the substantial (by a factor up to 60-100) difference in the payment for the work of "their" and Russian scientists the West is saving considerable sums. At the same time many enterprises, organizations, groups and individual scientists are ready for a pittance to convey scientific and technical attainments abroad; in some cases these surpass the world level and constitute a true national heritage of Russia. The brain drain and the sale of advanced technologies are especially dangerous in the sphere of the military-industrial complex, where these phenomena are directly related to

the weakening of defense potential and are creating a direct threat to the national security of the country.

In order to avoid the spread of such a practice, which recently has become extremely appreciable, and in accordance with an order of the RF president dated 11 February 1994, RP No 74, entitled "Monitoring Exportation From the Russian Federation of Individual Types of Raw Material, Materials, Equipment, Technologies and Scientific-Technical Information Which Can Be Used in Making Arms and Military Equipment," the government of the country adopted a special resolution No 197 (dated 10 March 1994).

Assurance of the organization of monitoring is delegated to a commission on expert monitoring under the RF Government, jointly with the Ministry of Foreign Economic Relations and the RF State Customs Committee. At the same time a resolution of the Russian Federation Government dated 5 July 1992, No 469, entitled "On Approval of the List of Individual Types of Raw Material, Materials, Equipment, Technologies and Scientific-Technical Information Which Can Be Used in Making Arms and Military Equipment," the exportation of which was monitored and carried out under licenses during 1992-1993, is no longer in force.

The new regulations on the procedures for monitoring the exportation of so-called dual-purpose goods and services, incorporated in a special list, provide for a complex of measures. This involves the preparation of and issuance of conclusions on the possibility of exportation, licensing and customs control. All the subjects of economic activity under the jurisdiction of the Russian Federation, concluding contracts for exportation (transfer, exchange) of the dual-purpose goods and services enumerated in the list, must without fail indicate the final users and end purposes of the exported goods and services. In addition, the contract stipulates the obligations of the importer, in accordance with which the goods and services must be used only for the declared purposes, unrelated directly or indirectly to the production of arms and military equipment and will not be reexported or conveyed to anyone whatsoever without a written export license. For all economic activity entities in RF territory it is mandatory that there be licensing of exportation (transfer, exchange) of the dual-purpose goods and services incorporated in the list, carried out by means of all types of foreign economic activity, including direct production and scientific-technical relationships, foreign trade and goods exchange operations. Exportation is carried out under single-use licenses issued by the RF Ministry of Foreign Economic Relations.

Under conditions of a sharp reduction in the funding of scientific research and experimental design work orientation on assistance from the West is legitimate. However, with respect to strategic interests and long-term goals of national scientific and technical development such a model of cooperation cannot be effective because it is leading to an intensifying dependence on Western donors and is creating a direct threat to the technologic security of the state.

In the prevailing situation there must be a search for new flexible forms of cooperation making it possible to proceed to a qualitatively different level of interrelationships which would be based on a mutually advantageous partnership. Joint projects, taking in the entire chain of work — from research to the stage of merchandising of a newly developed product — must become such a form of cooperation. This, in turn, requires fundamental solutions directed primarily to the development of a clear-cut scientific-technical policy; maintenance of the necessary level of funding of science, comparable to the level of civilized countries; creation of an appropriate infrastructure for the development of new effective forms of international cooperation in the science and technology field.

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Russia: Ministry of Science Reports on Results of State S&T Funding

964D0217A Moscow POISK in Russian 2-8 Dec 95
No 49, p 1

[Article by Angelina Fedorova under the rubric "At the Center of Events": "Maneuvers at the Edge of a Cliff"; first paragraph is POISK introduction]

[FBIS Translated Text] The reporting meeting of the board of the Ministry of Science for the ending year dealt with a report to the government on progress in implementing Decree No 360 "On State Support of Science and Scientific-Engineering Developments."

Taking the steps stipulated in the decree promptly enables the Science Ministry, along with other concerned ministries and agencies, to hold Russian science at the edge of a cliff. Last year, Russian scientists completed work on development of new types of machinery, technologies, and materials on a world level. The Science Ministry has selected 280 projects in virtually all directions of science and engineering, which were proposed for use in industry. Adoption of new developments promises to be exceptionally advantageous: profit from a third of them within less than 2 years will exceed investments by 5 times.

These 280 projects include ecologically clean technology to produce materials for the electronics industry, developed by the Soliton-NTT research center, and devices that permit controlled thermonuclear synthesis invented at the Institute of Applied Physics of RAS [Russian Academy of Sciences]. But of particular interest is the basically new type of material that is harder than a diamond, developed by the "Superhard Materials" scientific engineering center jointly with the RAS Institute of Spectroscopy. According to foreign scientists, this work was carried out on the level of a discovery.

Developments by Russian scientists enjoy much success at prestigious international exhibits. Thus, at the Hannover Messe exhibit in FRG more than 10 contracts were signed with firms in Germany, England, France and other countries. Export of Russian high-tech products and technologies to CIS states has also increased from 6 to 11 percent.

Still, as indicated in the proceedings of the board, it has not been possible to fully stabilize the scientific-engineering situation.

Enterprises are not rushing to adopt new developments. For this reason science is supported almost entirely by the federal budget. And this is hardly enough: according to expert estimates, in the last 3 years funding of science has diminished to less than one-fifth and has dropped below a critically dangerous level.

For the year under review, there was some improvement in implementation of the budget for science. Thus, in 11 months allocated funds constituted 72 percent and for the entire year the figure will be about 80 percent. However, considering inflation, there will be even less funds than in 1994. They will be enough for salaries and withholdings for social purposes.

In Decree No 360 the government ordered the Ministry of Finance to allocate to the Science Ministry funds in hard currency for patenting and support of advancement of Russian technological developments abroad, as well as to acquire scientific and copying equipment, office

equipment, materials and reagents, foreign scientific periodicals, and to support marine expeditions and repair of research vessels. However, the Ministry of Finance never did respond to all seven requests of the Science Ministry.

In such major research centers as Moscow and Moscow Oblast, St. Petersburg, Novosibirsk and Samara Oblast, and Krasnoyarsk Kray, local administrations have assumed part of the responsibility for funding science.

In the Science Ministry it is believed that adoption of a system of repayable funding of applied developments carried out at the expense of the federal budget could become an important source of funding Russian science. Thus, the process of commercialization of applied science could be accelerated, the role of the State could be increased as the buyer of developments, organizer of investment and entrepreneurial activities in the area of science and technology. The Science Ministry has prepared a draft of a government decree dealing with introduction in stages of a system of repayable funding

Russian Federation Basic Research Fund Reports 1995 Distributions

964D0217B Moscow POISK in Russian 2-8 Dec 95
No 49, p 3

[Article by Nataliya Borodina NAUKA B SIBIRI newspaper: "Basic Plus"]

[FBIS Translated Text] Representatives of the Russian Basic Research Fund (RBRF) worked for 2 days at the Novosibirsk Research Center: the chairman of this fund, Academician V. Fortov and doctors of sciences Yu. Bogachev and B. Levin, who head the chemistry and earth sciences departments, respectively. And they did work, with numerous meetings at institutes and management entities of the RAS SD [Russian Academy of Sciences Siberian Department]. There was also a meeting with the scientific community in the Small Hall of the RAS SD House of Scientists, where V. Fortov told about the work of the Fund, outlined prospects for the future, and answered questions. The speakers also included O. Bogachev and B. Levin. Scientists were standing in the hallways and bombarding the visitors with oral questions and notes.

The interest of RAS SD staff in the activities of the fund is understandable. Although there is no flow of publications about it as there is about the Soros Foundation, the annual funding of the department by RBRF, as stated by the chairman of the RAS Siberian Department Academician V. Koptug, constitutes more than 15 billion rubles [R] (let us remind the reader that the SD has 25 billion of budgetary funds). RBRF, which was founded 3 years ago, is presently a serious factor in

survival (and often not so meager) of Russian science. Being a self-managed State organization, it has at its disposable 4 percent of all funds allocated in the Russian budget to science. At present the figure has even grown somewhat, to 7 percent according to V. Fortov, at the expense of subsidies allocated by the State Duma to support the leading scientists of Russia and the program for development of telecommunications.

How are these funds distributed? Of the entire sum, 45 percent goes to the staff of RAS institutions and organizations situated in the center. The Siberian Department receives 9-10 percent (it is interesting to note that Moscow State University alone receives the same amount). The rest of the expenses are for support of basic research at other academies, research centers, VUZs [higher educational institutions] and laboratories. The RBRF can spend up to 5 percent of its budget to support its own apparatus, but in reality the sum does not exceed 1.5 percent.

All funds are distributed strictly on a competition basis. Scientists have a rather accurate understanding of this mechanism and we shall not discuss it here, although V. Fortov discussed in detail the structure of the Fund, work with projects undergoing the scrutiny of actually four expert evaluations (by independent experts, section, council of experts, Fund council). Ultimately the main problem is resolved: to support innovative scientific projects through a system of grants. This costs 70 percent of the funds. Publishing activity is funded by 3 percent. Establishment and development of information systems and data bases cost 5 percent of the Fund's budget (plus R61.3 billion from the State Duma). Development of the material and technical base of scientific organizations costs 11.5 percent; and in recent times special attention has been devoted to collective use centers. Last year the Fund doubled the aid to send people to foreign conferences (it must be borne in mind that the Soros Foundation no longer finances trips made by scientists, and RBRF is trying to help in some way). There is also the reserve of the Fund's executive committee (4 percent). It is used, for example, when emergency expeditions by scientists are needed, as was the case after the Sakhalin earthquake.

Thus, about 9000 scientific projects are funded plus 3500 jointly with the Soros Foundation. About 54,000 scientists in 1200 Russian organizations receive money on RBRF grants.

Like a mechanism of separating of a very narrow financial river into small brooks, the Fund strives to use a creative approach to the problem of supporting scientists. It was stated at the meeting that the list of priority directions is being constantly amended.

consideration is given to the difficulty of classifying even in great detail such a complex entity as modern science. V. Fortov spoke in detail about what will be basically new in the Fund's work next year.

First of all, there will be intensification of collaboration with foreign organizations, the activities of which are aimed at contact with Russian science.

In the first place, there is INTAS, the European organization for support of science in CIS states, which sends 80 percent of its funds to Russia. Before, its activities developed rather passively, but now they are accelerating. As noted by V. Fortov, "They are interested in working with us." True, the funding system of INTAS is different from MNF (Soros Foundation): you find a foreign partner and if your joint project is passed by the experts it is funded by INTAS and RBRF. INTAS is contributing \$4.2 million and RBRF is contributing the same amount to the program which was described in detail in POISK.

The German research society will also participate in saving our intellectual potential, contributing 2 million German marks (our contribution is the same) for joint projects.

The rules for screening for competitions were published in POISK No 40, where there is also a listing of conditions for obtaining grants through the joint competition held by RBRF and Chinese State Fund for Natural Sciences.

By decision of the State Duma, in 1995 an additional R61.3 billion were allocated to the Fund for a program to create and develop scientific telecommunications. The end goal of this program is to provide every scientific associate, instructor, graduate and undergraduate student with access to Russian and foreign data banks, library catalogues, scientific periodicals, and enable them to exchange scientific information with colleagues all over the world. V. Koptug acquainted the guests from RBRF with the status and plan for development of a system of information support of basic research at the Novosibirsk academic town. The institutes of the Siberian Department participate actively in creating information systems and databases, and development of the telecommunications network. Considerable advances have been made in this direction by the staffs of the institutes of organic chemistry, catalysis, computer technologies, chemical kinetics and combustion, and the RAS SD Computer Center.

V. Fortov devoted special attention in his speech to a new program for support of Russian scientific schools and outstanding scientists, for implementation of which the State Duma allocated R100 billion to RBRF in 1995.

The main purpose of the program is to preserve the scientific potential of the nation and prevent migration of leading scientists abroad, as well as to enhance the prestige of scientific work, provide appropriate living and working conditions for scientists in Russia. At the first stage, more than 24,000 scientists will receive financial support. It is particular important that two-thirds of them, more than 16,000, are young scientists, graduate students, interns, and upper division undergraduate students.

Thus, the spectrum of the Fund's activities is expanding, so that one needs to increase the role and importance of RBRF representation in different regions, in particular in Novosibirsk. V. Koptug discussed this in the general discussion with which the meeting ended.

V. Fortov, Yu. Bogachev and B. Levin answered questions of attendees at length and comprehensively, they conversed with grant recipients and those who were unlucky, offered concrete advice, and promised to look into individual problem situations. All this was included in the report on the 3 years of Fund operation. The guests from Moscow had come to look : and listen to those for whom they work in order to see whether everything is done properly in the complex mechanism of the Fund. To find flaws and remedies for them.

That is the impression gained. May it be correct.

Russia: Scientific Publishing Still at Low Point

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No 49, p 3

[Article by Igor Goryunov: "Grant After Grant — Library for Scientists"]

[FBIS Translated Text] Who among Russian scientists is quoted the most often by his foreign colleagues? What scientific institution do they represent? Answers to these and many other questions can be easily obtained by anyone who so wishes at the Conversion-95 exhibit held in Moscow.

There at the RBRF (Russian Basic Research Fund) booth there was exhibition of scientific works published with the Fund's support. It is reported in one of them, entitled "Russia's Contribution to Development of Science" by Irina Marshakova-Shaykevich, that staff members of the Institute of Theoretical Physics imeni L. Landau are the Russian authors most quoted in the world. They are followed by their colleagues at the Institute of Theoretical and Experimental Physics.

These conclusions resulted from analysis of a large number of scientific publications and citations in the editions of different countries. While working on this

book, its author used the database of the American Institute of Scientific Information located in Philadelphia, which lists a million references from all leading scientific periodicals of the world. Including Russian ones.

In addition, Marshakova-Shaykevich cites an enormous amount of other interesting information on different branches of Russian science. For example, how our scientific periodicals compare to foreign ones.

Unfortunately, the data submitted in this book are limited to 1993: it took about 2 years to prepare the manuscript and publish the book.

However, even for the time period studied by the author it is very apparent that there has been a dramatic drop in the number of scientific publications in Russia. While only the United States published more than the USSR in the mid-1980s, at the start of the 1990s the Russian Federation was already in fourth place, having been overtaken by Japan and Great Britain. In 1993, we were already in sixth place, following these 3 countries, France and FRG.

But it is not only the number of publications by Russian scientists that has dropped. Books on physics, mathematics, astronomy and other basic disciplines have disappeared from the shelves of bookstores. This was related to collapse of the system of scientific book publishing and appropriate distribution system.

In this matter the situation is very serious even now, although RBRF is making a contribution to improve it. It is not by chance that 75 percent of the books exhibited in the booth deal with physics and mathematics. For example, the first published scientific works of Academician A. Sakharov. Or "Guide on Common Differential Equations" compiled by Valentin Zaytsev and Andrey Polyanin, which is much needed by a wide range of specialists. After all, accurate solutions to differential equations play an enormous role in proper comprehension of qualitative distinctions of many phenomena and processes in various branches of natural science.

On the whole, RBRF is currently financing 304 books. Of this number 150 will be published in 1995. The remaining 154 will be published in 1996, and another 200 will be added at the expense of grants for next year.

Nevertheless, there are obviously not enough books and they are expensive. For this reason not every scientist, who sometimes receives no salary for several months at a time, can afford to buy a copy essential to him, particularly if it is a book by a foreign author.

In such cases we must only hope for a new information miracle in Russia, the Internet. Expressly this telecommunications network provides our institutes, educational institutions, scientists, teachers, graduate and undergraduate students with the opportunity to obtain the latest scientific information in a timely fashion.

For example, Elsevier, the world's largest Dutch scientific publishing house, is presently publishing all of its periodicals (more than 1000) not only in hard copy, but also electronically. Thus, anyone who wishes, if he has a computer linked to Internet, can obtain almost instantaneously a needed article. As well as books and periodicals from catalogues of libraries of most countries in the world.

However, all these potential possibilities are offered only to those who know how to use global information networks. The book by Stanislav Klimenko and Vasil Urazmetov, "Internet: the Habitat of Information Society," is called upon to be of substantial aid in learning such skills. It explains in rather simple terms how to use a system that now has 40 million users all over our planet.

This book has had such a success in the scientific community that the Fund's executive committee has decided to finance an additional printing, even though the book has just come off the presses.

Russia: Modeling of Small-Scale Influence of High-Altitude Aircraft Engine Exhaust on Atmospheric Composition

964D0190A Moscow *FIZIKA ATMOSFERY I OKEANA in Russian*
Vol 31 No 4, Jul-Aug 95 pp 507-516

[Article by I. L. Karol and Yu. E. Ozolin, Main Geophysical Observatory imeni A. I. Voyeykov; UDC 551.510.41 (manuscript received 8 Sep 93, after revision 24 May 94)]

[FBIS Summary] An estimate is made of the impact exerted on atmospheric composition by the exhaust from the engines of a single aircraft during flight at altitudes 10, 16 and 24 km (mean annual atmospheric conditions are considered). A box diffusion-photochemical model for a flight trajectory section is used with allowance for heterogeneous reactions in the condensation trails of effluent in the troposphere and in the sulfate aerosol in the stratosphere and with an intensified horizontal propagation of the exhaust. The composition and quantity of combustion products employed in the modeling and the diurnal changes in ozone and gases active relative to it for a narrow exhaust jet were the same as in a study by M. Yu. Danilin, et al., *ANN. GEOPHYSICAE*, Vol 10, No 2, pp 904-911, 1992 ("Short-Term Atmospheric Effects of High Altitude Aircraft Emissions"), but in a broad jet were computed for a period of 24 hours for the cases of midday and midnight emissions. The results indicate a significant dependence of the degree and duration of the ozone drop in the jet on its size and the discharge level. The narrower the jet, the greater and more prolonged is the ozone drop, more significant in the stratosphere than in the troposphere. The nighttime ozone dropoff is greater than the daytime dropoff, but less prolonged in both jets and at all the considered altitudes. In general, however, in a more realistic broad jet the dropoff in ozone content is small and of short duration and exerts no appreciable influence on the total ozone content. The results of model computations show a considerable but brief dropoff of ozone content with a subsequent restoration to the level 99 percent of its initial content over the course of 1 hour for a broad jet and over the course of more than 24 hours for a narrow jet. The transformation of NO and NO₂ into HNO₃ is insignificant in all the considered cases, which is consistent with the results obtained in the Danilin study. In

contrast to the latter it was found, however, that heterogeneous chemistry may exert a substantial influence on evolution of the content of NO₃, N₂O₃ and HO₂ in the exhaust jet. Figures 8; references 18: 6 Russian, 12 Western.

Russia: Charged-Particle Accelerators of 'Troll' Type as Feasible Space Research Tools

964D0198A Moscow *KOSMICHESKIYE ISSLEDOVANIYA in Russian*
Vol 33 No 5, Sep-Oct 95 pp 468-473

[Article by V. S. Panasyuk, All-Russian Scientific Research Institute for Optophysical Measurements, Moscow; UDC 581.521 (manuscript received 3 Nov 94)]

[FBIS Summary] A new fundamental direction in experimental physics, synthesizing charged-particle accelerators and ultrastrong magnetic fields technology, receiving the designation "Troll Project," embodies diverse possibilities for use in different fields of science and engineering. In particular, accelerators of the "Troll" type — generators of medium-energy accelerated particles and synchrotron radiation — due to their miniaturization and extremely simple design afford the possibility of raising the question of their use in space. A few of these possibilities are: calibration of star brightness on the basis of synchrotron radiation (SR) and use of SR for experiments with photoionization of the upper layers of the atmosphere or radio communication in the case of special conditions for the transmission of radio waves. The basis for this direction is the poorly studied physics of powerful circulating beams of charged particles of a small radius and of intermediate and great energy. The characteristic orbital radius from a few to tens of millimeters is determined in the last analysis by the size of the electromagnets of strong (ultrastrong) magnetic fields. The SR of these miniaturized and simple new accelerators, fitting together well with complex optical systems, is a subject for basic research for developing free-electron lasers. The article is essentially a review of the studies of the author and his associates and proposals of the author needing thorough theoretical study by specialists working in the space research field. In addition, it may give rise to discussions which will be useful along these lines. Figures 4; references: 14 Russian.

Russia: Determining Dynamic Parameters of Space Vehicle From Results of Optical Measurements

964D0198B Moscow KOSMICHESKIYE

ISSLEDOVANIYA in Russian

Vol 33 No 5, Sep-Oct 95 pp 491-497

[Article by V. M. Borodin, O. R. Kayumov, V. N. Skimel and Yu. N. Fedorov, Kazan State Technical University; UDC 531.383 (manuscript received 12 Apr 94)]

[FBIS Summary] A study was made of the motion of an artificial satellite about its center of mass as formulated in an integrated Euler-Poinsot problem. It is postulated that the distribution of satellite mass is close to dynamically symmetric and that the satellite carries an optical sensor generating a signal every time that the sensor enters into its zone of sensitivity to light from a fixed star. The article examines an algorithm making it possible on the basis of data from the statistical processing of such signals to identify the dynamic parameters of a satellite. The proposed method makes it possible from the set $\gamma = (t_1, \dots, t_n)$ of moments in time of entry of the signal into the plane of the sensor slit in a Euler-Poinsot case to determine the important dynamic parameters m , $\cos T$, μm . The method is based on use of the regular properties of the Q sample and with a sufficiently great n has a low sensitivity to inaccuracy in measuring individual moments in time. In addition, construction of the $x(t/T_n)$ makes it possible to exclude from the sample individual inexact signals or to detect brief changes in the spacecraft motion mode. The algorithm makes it possible to answer the question: does the investigated motion correspond to the Euler-Poinsot case, a characteristic property of which is limitation and periodicity of the time nonclosures curve? Figures 7; references: 4 Russian.

Russia: Optimum Control of Spatial Turn of Spacecraft

964D0198C Moscow KOSMICHESKIYE

ISSLEDOVANIYA in Russian

Vol 33 No 5, Sep-Oct 95 pp 498-502

[Article by M. V. Levskiy, Energiya Rocket Space Corporation imeni S. P. Korolev, Kaliningrad, Moscow Oblast; UDC 629.7 (manuscript received 20 Jun 94)]

[FBIS Summary] Although the problem of optimum control of the spatial turn of a spacecraft has been examined in many formulations, these do not include optimization of spacecraft reorientation with respect to the criterion of minimum fuel expenditure. Until now no method has been developed which makes possible an analytic solution, in general form, of the problem of spatial reorientation of an asymmetric spacecraft using

the fuel expenditure minimum criterion. An appropriate algorithm is written for numerical determination of the controls meeting all the necessary requirements. Control laws are formulated which are free of traditional assumptions. The problem of control of the spatial turn of a spacecraft with a minimum expenditure of the working medium is examined for the case of spatial reorientation of an asymmetric spacecraft using the fuel expenditure minimum criterion and with restrictions on control. An algorithm is proposed for numerical determination of the controls which ensures a stipulated reorientation accuracy. The predictive model is such that its selected form allows prediction of "free" motion in the class of spacecraft motion in conical trajectories in which the direction of the kinetic moment of a dynamically symmetric spacecraft remains unchanged in an inertial reference system. This makes it possible to obtain a solution of the problem of search for optimum control of an arbitrary turn of a spacecraft by the iterations method. A solution of the formulated problem is found in the class of two-impulse control, with allowance for external perturbing factors. The practical applicability of the proposed turning scheme is demonstrated. The results of mathematical simulation confirming the high efficiency of the resulting control are given. An example of the mathematical modeling is given. Figures 2; references: 6 Russian.

Russia: Constructing Region of Spacecraft Maneuvering During Atmospheric Entry at Quasicircular Velocity and Large Entry Angle

964D0198D Moscow KOSMICHESKIYE

ISSLEDOVANIYA in Russian

Vol 33 No 5, Sep-Oct 95 pp 503-512

[Article by R. Z. Khayrullin, Applied Mathematics Institute imeni M. V. Keldysh, Russian Academy of Sciences; UDC 629.136 (manuscript received 8 Nov 94)]

[FBIS Summary] A solution is given for the problem of constructing the region of spacecraft maneuvering in the plane of parameters "final altitude-final flight range" upon entry into the atmosphere with a quasicircular velocity and at a great entry angle. It was found that trajectories leading to the boundary of the maneuvering region will be ricocheting. In this case the maximum flight range is ensured on trajectories with several ricochets. The number of ricochets is dependent on the aerodynamic quality of the spacecraft. The maximum flight altitude is ensured on the first ricocheting segment. In addition, for spacecraft with a high aerodynamic quality the local altitude maximum may be ensured on the second ricocheting segment. The structure of the maneuvering region is clarified. It was found that this re-

gion is a combination of several intersecting "primary regions," constructed for different families of trajectories with a fixed number of ricochets. The boundary of the maneuvering region contains several angular points. The dependence of flight altitude on range corresponding to the upper boundary of the indicated region may have several local maxima. A simple method is proposed for computing optimum trajectories and controls. A constructive approach to study of dynamic controllable systems based on the combined use of different optimization methods is proposed. Figures 5; references 10: 9 Russian, 1 Western.

Russia: Optimum Trajectories for Return of Spacecraft With Jet Engines of Great Limited Thrust From Moon to Earth

964D0198E Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian
Vol 33 No 5, Sep-Oct 95 pp 513-532

[Article by K. G. Grigoryev and I. S. Grigoryev, Moscow State University imeni M. V. Lomonosov; UDC 629.195.3+517.977.52 (manuscript received 17 Sep 94)]

[FBIS Summary] The optimum trajectories for return of a spacecraft with jet engines of great limited thrust, controlled by the thrust vector, corresponding to spacecraft flights in the lunar orbital plane with a maximum final mass with a limited flight time or to the most rapid flights with a limited final mass, have been determined. The optimum flight trajectories are examined, especially multirevolution optimum trajectories, from the orbit of an artificial lunar satellite and from the lunar surface to the orbit of an artificial earth satellite and to the boundary of the Earth's atmosphere with stipulated conditions for atmospheric entry. The research was carried out on the basis of the maximum principle within the framework of the restricted circular three-body problem with solution of boundary value problems by the shooting method. The method used in the study can evidently also be used in solving similar problems of optimum flights of spacecraft between other planets and their natural satellites on the basis of the maximum principle within the scope of the restricted circular three-body problem. The following extensive tables are provided: Table 1 — Flights between artificial lunar satellite and artificial earth satellite orbits; Table 2 — Flights between

lunar surface and orbit of artificial earth satellite; Table 3 — Flights between orbits of artificial lunar satellites and boundary of Earth's atmosphere; Table 4 — Flights between lunar surface and boundary of Earth's atmosphere. Figures 6; references: 25 Russian.

Russia: Robust Method for Reconstructing Descent Trajectory of Small Planetary Station Onto Martian Surface

964D0198F Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian
Vol 33 No 5, Sep-Oct 95 pp 533-537

[Article by P. R. Ivankov, Central Scientific Research Institute for Machine Building, Kaliningrad, Moscow Oblast; UDC 519.92:523.4²] (manuscript received 31 Oct 94)

[FBIS Summary] The problems involved in postflight determination of the trajectory of descent of a small planetary station onto the Martian surface are examined. The solution of this problem is complicated by the fact that there is a great a priori uncertainty in atmospheric entry conditions. In such a situation known methods prove to be highly sensitive to small errors in the mathematical model of motion of a small planetary station of such a type. A method for reconstructing the trajectory of such a small station which is resistant to these errors is proposed. Numerical results of assessment of method efficacy are given. An algorithm is written which ensures determination of the density profile on the basis of data from measurements of apparent acceleration and the stipulated initial phase vector. Depending on the a priori scatters of entry conditions and atmospheric parameters this algorithm makes it possible either to ascertain atmospheric parameters more precisely or to solve the inverse problem of assessing the parameters of motion. The modeling indicated that the latter problem can be solved under conditions of flight of a small planetary station. Study of the constructed tubes indicated that the method makes it possible to ascertain the velocity tubes, angle of trajectory inclination and altitude and it is shown that the width of these tubes changes extremely insignificantly. A determination of the range of the atmospheric segment of the flight is particularly effective. Figures 6; references: 6 Russian.

Russia: Flexible Controllable Spacecraft With Perturbations From Internal Sources

964D0198G Moscow KOSMICHESKIYE
ISSLEDOVANIYA in Russian
Vol 33 No 5, Sep-Oct 95 pp 538-545

[Article by Ye. Ye. Malakhovskiy and E. L. Poznyak (deceased), All-Russian Electromechanics Scientific Research Institute, Moscow, and A. A. Shulyaka, Electromechanics Scientific Research Institute, Istra; UDC 629.78 (manuscript received 31 Mar 94)]

[FBIS Summary] A study was made of the problem of modeling of the rotational motion of a controllable flexible spacecraft in the case of presence of perturbations from internal sources, such as drives for the orientation of panels, antennas and scanners, whose operation is accompanied by strong generation of an entire spectrum of LF forms of spacecraft structural oscillations. The features of system behavior are illustrated in the example of an analysis of the dynamics of a newly developed modification of a spacecraft of the Meteor type. The limited possibilities of the control system also are demonstrated with respect to stabilization of angular oscillations of the spacecraft body if the latter are caused by excitation of elastic forms of structural oscillations. The problem is solved with a number of assumptions. It is shown that the control system is sufficiently effective only with the suppression of oscillations of the vehicle as a rigid body. The presented analysis convincingly shows that the traditional system for control of angular orientation of the body does not make it possible to ensure satisfaction of the increased requirements on the levels of angular destabilization imposed on modern data-generating spacecraft. The approach proposed in the study makes it possible to regard the problem of the dynamic accuracy of stabilization for such systems in the more general formulation of "decentralized" control on the basis of purposeful choice of the places of positioning and orientation of the actuating mechanisms and synthesis of their control systems with allowance for the characteristic modal features of structure of the flexible vehicle, as well as the spectral pattern of effects from internal sources of perturbations. Figures 5; references 13: 4 Russian, 9 Western.

Russia: Natural Gas Pushed as Alternative, Less Expensive Fuel

964D0144A Yekaterinburg OBLASTNAYA GAZETA
in Russian 4 Oct 95 p 2

[Article by Irina Dunyashina: "Diesel Locomotive at Rocket Launch"]

[FBIS Summary] Boris Nekrasov, director of NIImash (Machine Building Scientific Research Institute), has described how efforts are being made to adapt a diesel locomotive engine to operate on a fuel close in its properties to that used in the rocket branch. Liquid hydrogen would be the natural choice, but it is far too costly. Work is therefore being done on testing of the systems of the 2T31-OG diesel locomotive for operation on liquefied natural gas. This work is being done on a test stand for rocket engines of the Energiya-Buran system. Compressed to a density a little less than half the density of water and cooled to 146°C, the gas becomes a cryogenic fluid. This and similar work is being done today within the scope of the Russian Federal Program for Expanding Use of Natural Gas. The NIImash is undertaking such work even prior to official approval and funding of the program. Under this program Russia will pursue a policy of giving preference to natural gas over other types of fuel in thermal power engineering and an effort will be made to replace traditional motor fuels by compressed and liquefied natural gas. The explored reserves of natural gas greatly exceed those of crude petroleum and the ecologic impact of natural gas is far less than that of motor fuels based on petroleum. In the Ural region it is not only the NIImash which is working within the scope of the future program. The Avid Association in Perm is engaged in developing aircraft engines and a power plant operating on natural gas. The Start Special Design Bureau is working on an equipment complex for use of liquified natural gas in transportation and agriculture. The price of natural gas as a motor fuel is almost half the price of diesel fuel or gasoline. It also is planned that liquified natural gas will be used in providing power for shipping on the Ob and Irtysh Rivers. The annual savings by substituting natural gas for diesel fuel will be enormous, even on a local basis. And less harm will be inflicted on the environment, fewer lubricants will be needed and there will be lesser wear on engines.

Russia: Critical Current Density in Rail Guns with Composite Electrodes

964D0228A Novosibirsk PRIKLADNAYA
MEKHANIKA I TEKHNICHESKAYA FIZIKA
in Russian No 3, May-Jun 95 pp 10-17

[Article by S. V. Stankevich, G. A. Shvetsov, M. A. Lavrentyev Institute of Hydrodynamics, Siberian Division, Russian Academy of Sciences, Novosibirsk; UDC 583.4+533.95 (manuscript received 26 Sep 94)]

[FBIS Summary] This paper studies the possibility of increasing the critical current density in rail guns which use composite electrodes with various structures. Four electrode types are studied: a homogeneous electrode (the standard), an electrode with a cover layer, and electrode with vertical layers of various metals, and a composite consisting of a mixture of particles. The solid body is accelerated by a plasma piston. In electrodes with a cover layer and those with metal layers the melting of the metal and separation of the electrode is a potential problem which must be considered. Electrodes made of particle mixtures made by compacting powders may be promising. The maximum increase in the critical current density occurs when the maximum size of the particles forming the composite is much smaller than the thermal skin layer. In this case the critical current density will be independent of the thermal flux. It is found that at least one component of the composite should stay solid despite heating. Figures 4; tables 3; references 11: 1 Russian, 10 Western.

Russia: Magnetic Accumulation Generators. Selection of Optimal Experimental Conditions

964D0228B Novosibirsk PRIKLADNAYA
MEKHANIKA I TEKHNICHESKAYA FIZIKA
in Russian No 3, May-Jun 95 pp 18-23

[Article by A. M. Trubachev, M. A. Lavrentyev Institute of Hydrodynamics, Siberian Division, Russian Academy of Sciences, Novosibirsk; UDC 537.639 (manuscript received 10 May 94)]

[FBIS Summary] Very strong magnetic fields (1-15 MG) are obtained by rapid compression of the magnetic flux of a conducting casing. Explosive experiments in magnetic accumulation generators have been conducted, but it is difficult to select initial generator parameters to obtain the maximum field with available equipment. This paper systematically studies published results on obtaining very strong magnetic fields with magnetic accumulation generators. Analysis is limited to field amplification, b , and the ratio of the kinetic energy of the liner to the magnetic energy in the compressed volume

at the beginning of compression, e . This eliminates individual differences between experiments to focus on the results. A method is proposed for the selection of the initial magnetic field of the generator which makes it possible to select optimal experimental conditions in a small number of steps. Analysis of existing data shows that most of the experiments have been inefficient. The maximum value of b that has been obtained with existing equipment is 200. Optimal operation of a magnetic accumulation generator requires a selection of the initial magnetic field so that $e = b \leq 200$. Most previous experiments do not meet this criterion. Figures 2; table 1; references 16: 3 Russian, 13 Western.

Russia: Development of Disturbances at the Interface of Two Gases Accelerated by a Shock Wave

964D0228C Novosibirsk PRIKLADNAYA
MEKHANIKA I TEKHNICHESKAYA FIZIKA
in Russian No 3, May-Jun 95 pp 24-30

[Article by S. M. Bakhrah, B. A. Klopov, Ye. Ye. Meshkov, A. I. Tokshmyakov, Yu. V. Yanilkin, All-Russian Scientific Research Institute of Experimental Physics, Arzamas-16; UDC 532.5:519.63 (manuscript received 2 Feb 94; after revision 27 Jun 94)]

[FBIS Summary] The interface of two media with differing densities is unstable if the constant acceleration is directed from the light medium to the heavy medium. Small initial disturbances increase exponentially. The boundary is stable if the acceleration is directed from the heavy medium to the light medium. When acceleration is due to a shock wave, the small amplitude of the initial sinusoidal disturbance increases linearly over time. A shock wave causes instability even in movement from the light to heavy medium. Experimental and modeling results are presented on the development of finite disturbances of various shapes. The range of amplitudes of the initial disturbance is $0.2\lambda \leq \Delta_0 \leq 0.8\lambda$. Numerical and experimental results are compared. The effect of the magnitude and shape of the initial disturbance is considered. The relative rate of growth of the amplitude of the initial disturbance, $(d\Delta/dt)\Delta_0$, decreases as Δ_0/λ increases for all boundary shapes and decays. For a sinusoidal disturbance the decrease in the relative rate of increase in disturbance amplitude follows a linear law. The rate of increase in the disturbance amplitude depends greatly on the shape of the boundary, but this smooths out as the initial amplitude increases. For sinusoidal disturbances there is a linear increase in amplitude with time until it increase by a factor of 3-4. At this point the shape is very different from the original shape. Figures 7; references 12: 9 Russian, 3 Western.

Russia: Effective Method of Calculating the Wave Resistance of Bodies of Revolution with a Transonic Range of Velocities

964D0228D Novosibirsk PRIKLADNAYA MEKHANIKA I TEKHNIЧЕСKAYA FIZIKA in Russian No 3, May-Jun 95 pp 60-67

[Article by M. A. Nayda, A. S. Fonarev, Central Aerohydrodynamic Institute, Zhukovskiy-3, Moscow Oblast; UDC 533.6.011 (manuscript received 5 Jul 94)]

[FBIS Summary] A new and effective numerical algorithm is developed to calculate the wave resistance of the bodies of revolution in a transonic stream of ideal gas. The theory of small perturbations is used. A formula is presented for the resistance of bodies of revolution in a steady state transonic flow. The wave resistance is calculated for several bodies of revolution. Numerical results are obtained for the resistance of a complex three-dimensional aircraft configuration with an elongated body at near-sonic (above and below) velocities. Numerical results are compared with experimental results. Figures 5; references 13: 5 Russian, 8 Western.

Russia: Effect of Heating on the Split-Off Destruction of Composites made of SKTN Rubber

964D0228E Novosibirsk PRIKLADNAYA MEKHANIKA I TEKHNIЧЕСKAYA FIZIKA in Russian No 3, May-Jun 95 pp 167-169

[Article by V. K. Golubev, G. Kh. Korshunova, Yu. S. Sobolev, All-Russian Scientific Research Institute of Experimental Physics, Arzamas-16; UDC 539.4 (manuscript received 6 May 94)]

[FBIS Summary] Elastomer-based composites are frequently used in structures subjected to large dynamic loads and high temperatures. The effect of heating temperature on split-off durability of composites based on SKTN rubber with a high filler content is studied. The composite contains 80 percent by mass of a fine disperse mixture of metal oxides. The filler particle size is 1.5-30 μm . In this experiment disks 30 mm in diameter 3 mm thick were fixed to an aluminum screen (80 mm in diameter, 8 mm thick). The disk were subjected to the impact of a plate with the screen. The plate was accelerated by explosive detonation. Samples were heated by thermocouples. After testing, the disks were visually inspected, and in the absence of visible defects, sectioned. The experimental results indicate the substantial effect of high temperatures on split-off durability in the

composite. At normal temperature the maximum pressure at which the disk maintained its integrity was 300 MPa (with complete breakage at 444 MPa); at 150°, the figure was 380 MPa (breakage at 518 MPa); and at 250°, 300 MPa (breakage at 472 MPa). A table gives a description of the condition of the disk, temperature, impact velocity and pressure. Figure 1; table 1; references 2 (Russian).

Russia: Photoresistive Effect in Tunneling Transitions in δ -Doped GaAs/Metal

964D0004A Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 62, Nos 1-2, 10-25 Jul 95 pp 48-53

[Article by I. N. Kotelnikov and A. Ya. Shulman, Radio Engineering and Electronics Institute, Russian Academy of Sciences, N. A. Varvanin and S. D. Ganichev, Physical Technical Institute imeni A. F. Ioffe, and B. Mayerhofer and W. Prettl, Applied Physics Institute, Regensburg University (manuscript received 26 May 95)]

[FBIS Summary] It was found that there is an increase in the resistance of the tunneling transition formed by a two-dimensional electron gas of δ -doped GaAs and a metal film on the surface of a semiconductor under the influence of pulsed radiation of a laser operating in the submillimeter (wavelengths 90.55 and 250 μm , pulse duration 100 ns) range with optical pumping from a CO₂ laser. This response is opposite in sign to that which might be expected from heating of two-dimensional electrons by a radiation field. In order to clarify the nature of this phenomenon a study was made of the photoresponse of GaAs structures with a δ -doped layer in the temperature range 77-300 K. The samples used were prepared by the molecular beam epitaxy method and constituted structures with a δ -doped layer 2,000 Å thick grown at a distance 200 Å from the GaAs surface. It is shown that the heating of electrons occurs in the δ layer and is responsible for photoconductivity of a positive sign caused by a change in resistance of the δ layer itself. A comparison is made with the photoresistive effect in a three-dimensionally doped tunneling transition with a Schottky barrier, and the possible mechanisms of formation of ponderomotive forces from the field of an electromagnetic wave, exerting an influence on tunneling resistance in the case of a two-dimensional electron gas, are discussed. Figures 4; references 8: 3 Russian, 5 Western.

Russia: Symmetry and Anisotropy of Semiconductor Gap in Layered Cuprates: Analysis of Photoemission Experiments and Influence of Defects on Critical Temperature

964D0004B Moscow PISMA V ZHURNAL
EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI
in Russian Vol 62, Nos 1-2, 10-25 Jul 95 pp 53-58

[Article by A. V. Krashenninnikov, L. A. Openov and V. F. Yelesin, Moscow State Physical Engineering Institute (manuscript received 26 May 95)]

[FBIS Summary] One of the principal problems in research on high-temperature superconductors (HTSC) is determination of the superconducting gap $\Delta(k)$ (k is a quasipulse) in the CO_2 plane, because solution of this problem could considerably reduce the number of disputed models of HTSC superconductivity, which arbitrarily can be divided into two groups: with s- and d-symmetry. The experimental data are ambiguous. Solution of this problem can be greatly facilitated by a comparison of experimental data and the results of theoretical computation of a number of characteristics in semiconductors with different types of pairing. In seeking a solution, emphasis was therefore on dependence of the critical temperature T_c on the concentration of defects. The anisotropy parameter χ in the formula for the dependence of critical temperature T_c on the concentration of defects was computed on the basis of experimental studies of the Fermi surface, and the superconducting gap Δ in high-temperature superconductors was studied by the photoemission spectroscopy method. It was found that the hypothesis of s-pairing makes it possible to reconcile the strong angular dependence of Δ in the plane a-b with the relatively weak sensitivity of T_c to atomic disordering. In this case $\chi \approx 0.1$ is an order of magnitude less than with d-pairing ($\chi = 1$) and with highly anisotropic s-pairing ($\chi = 1$). The physical reason for the small χ value is discussed because it seems contradictory to the strong angular dependence $\Delta(k)$ in the CuO_2 plane. It was found that this is the result of an insignificant $\Delta(k)$ change on the Fermi surface described by the cited dispersion law. Figures 3; references 14: 3 Russian, 11 Western.

Russia: Self-Focusing Instability of Two-Dimensional Solitons and Vortices

964D0004C Moscow PISMA V ZHURNAL
EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI
in Russian Vol 62, Nos 1-2, 10-25 Jul 95 pp 95-101

[Article by E. A. Kuznetsov, Landau Institute of Theoretical Physics, Russian Academy of Sciences, and J. Juul Rasmussen, Department of Optics and Fluid Dynamics, Riso National Laboratory, Roskilde, Denmark

(manuscript received 16 May 95, after revision 20 Jun 95)]

[FBIS Summary] The instability of two-dimensional solitons and vortices is demonstrated within the framework of the three-dimensional nonlinear Schrodinger equation. This instability can be regarded as an analogue of Kadomtsev-Petviashvili (K-P) instability of one-dimensional acoustic solitons in media with positive dispersion. For large distances between these vortices this instability is transformed into the Crew instability of two vortex filaments with opposite circulations. The observed instability is of the self-focusing type. In the nonlinear stage a self-focusing tendency would result in the division of 2D solitons or dipole vortices into separate cavities. For vortex filaments, these cavities resemble vortex rings. Such an assumption means that the cavity formation process within these limits should be accompanied by the reconnection of vortex filaments. If initially the soliton distribution has no zeros it can be assumed that this leads to cavitation, to the appearance of a zero in the density profile, and at later stages to the generation of vortex rings. The main result would be that vortex filaments of opposite circulation would reconnect whenever they come within a distance of a few core radii of one another. Further support for such a scenario of instability development is the collapse of acoustic waves, which can be regarded as the nonlinear stage of K-P instability of solitons. Theoretical and numerical study of acoustic collapse revealed a tendency to a catastrophic decrease in the density profile for small-amplitude solitons. Study of nonlinear development of dark soliton instability revealed formation of a point vortex street similar to the Karman street in fluids. All the accumulated facts support the proposed hypothesis, which should be provable by a three-dimensional numerical experiment. References: 22 Western.

Russia: Simultaneous Observation of Vortices and Dislocations in Thin BSCCO (2212) Monocrystals

964D0004D Moscow PISMA V ZHURNAL
EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI
in Russian Vol 62, Nos 1-2, 10-25 Jul 95 pp 139-143

[Article by R. Batto, L. Ya. Vinnikov, L. A. Gurevich, and M. V. Dugayev, Solid-State Physics Institute, Russian Academy of Sciences (manuscript received 15 Jun 95)]

[FBIS Summary] The authors recently for the first time were able to observe vortices and dislocations in monocrystals of the high-temperature superconductor BSCCO (2212). It was found that in the initial (undeformed) monocrystals it is common to encounter dislocation structures which make it possible to study

the interaction between vortices and individual dislocations. An electron microscope was used in observing such dislocations and vortical structures in thin BSCCO monocrystals. These structures were reduced to a visible form using very fine ferromagnetic particles to disclose the relevant patterns. The described and similar patterns give evidence that individual dislocations do not destroy the distant order in the vortex lattice. In such cases the dislocation lines are perpendicular to the magnetic field and accordingly, to the vortices. However, clusters of dislocations cause appreciable changes in the near order in the neighborhood of the dislocation lines. These distortions can be interpreted to be a result of attraction of vortices to dislocations because the vortices for the most part "sit" on the dislocation lines. A weak attracting interaction was discovered between the dislocations and vortices which was not dependent on the type of dislocations. The possible reason for the attraction is a suppression of the order parameter in the dislocation nucleus. The authors do not regard the attraction of vortices to be rigorously experimentally demonstrated in either this study or in the foreign literature because point defects also play an important role in vortex lattice pinning. Nevertheless, it is hoped that use of the proposed combination of methods for the visualization of vortices and dislocations can be used in a final solution of the problem by using more perfect samples or thermal processing for the annealing of point defects. Figure 1; references 9: 2 Russian, 7 Western.

Russia: Proportional Chambers with a Working Area of 2x1 m² of the EKSCHARM Spectrometer

964D0184A Moscow PRIBORY I TEKHNIKA
EKSPERIMENTA in Russian
No 4, Jul-Aug 95 pp 8-20

[Article by A. N. Aleyev, V. A. Arefyev, V. P. Balandin, V. K. Birulev, I. Veresh, B. N. Guskov, P. Zalan, A. I. Zinchenko, I. M. Ivanchenko, Z. M. Ivanchenko, A. F. Kamburyan, M. N. Kapishin, N. N. Karpenko, G. A. Kvirikashvili, V. D. Kekelidze, D. A. Kirillov, I. G. Kosarev, N. A. Kuzmin, M. F. Likhachev, A. N. Maksimov, A. Sh. Mestvirishvili, A. N. Morozov, A. K. Odishvili, Ya. Pazoni, V. V. Palchik, T. G. Pitshelauri, Yu. K. Potrebennikov, V. A. Sashin, V. N. Spaskov, G. T. Tatishvili, P. Z. Khristov, Joint Institute of Nuclear Research, Dubna, Moscow Oblast; UDC 539.1.078 (manuscript received 27 Apr 94)]

[FBIS Summary] The EKSCHARM magnetic spectrometer was designed to study near-threshold hadron generation of charmed particles and to search for exotic hadron states at the Serpukhov accelerator. Proportional chambers located before and after the spectrometer act as charged particle coordinate detectors. Larger propor-

tional chambers were needed after the spectrometer, and these were developed jointly by the Joint Institute of Nuclear Research in Dubna and the Central Institute of Physical Research in Budapest. This paper describes the design and electronic recording equipment of these chambers, which have a working area of 2x1 m² and a winding step of the signal wires of 2 mm. Specifications of the chambers are presented. A gas mixture of Ar + 20% C₄H₁₀ + 3% C₄H₉OH + 0.3%CF₃Br was used to achieve a charged particle registration effectiveness of 98 percent. The length of the plateau of the curve of the dependence of chamber effectiveness on high voltage is 350 V. The spatial resolution of the chamber varies from 0.69 to 0.75 mm depending on the angle of incidence of the charged particle in the coordinate plane. The inclusion of these chambers in the region beyond the magnet provided the required accuracy in reconstructing the trajectories of secondary charged particles. The new chamber greatly expanded the phase volume which could be studied in the generation of charmed particles in neutron-nucleus interactions and increased the geometric effectiveness of the recording of charmed particles and exotic hadron states by nearly an order of magnitude. Figures 11; references 7: 5 Russian, 2 Western.

Russia: Study of the Radiation Hardness of New Optical Materials

964D0184B Moscow PRIBORY I TEKHNIKA
EKSPERIMENTA in Russian
No 4, Jul-Aug 95 pp 36-47

[Article by V. G. Vasilchenko, S. I. Kuptsov, A. S. Solov'yev, I. I. Buchinskaya, A. A. Bystrova, Z. I. Zhmurova, Ye. A. Krivandina, B. P. Sobolev, Yu. A. Krechko, Yu. D. Motin, A. V. Antipov; Institute of High-Energy Physics, Protvino, Moscow Oblast, A. V. Shubnikov Institute of Crystallography, Russian Academy of Sciences, Moscow Engineering-Physical Institute, Moscow, Institute of Nuclear Physics, Protvino Branch, Siberian Division, Russian Academy of Sciences; UDC 546.161+541.12.012+458.51 (manuscript received 17 Feb 94; after revision 14 Jun 94)]

[FBIS Summary] Results are presented of a study of the luminescent and radiative characteristics of new scintillators, a series of heavy crystals based on CdF₂, BaF₂, LaF₃, Pb_{0.97}Cd_{0.03}F₂, Na_{0.9}Yb_{0.1}F₂, Y₃Al₅O₁₂ and the lead glass F-13. Research showed that crystals based on CdF₂ with additions of YbF₃, BiF₃ and InF₃ were radiation hard to more than 10 Mrad and had short de-excitation times. Pb_{0.97}Cd_{0.03}F₂ and Na_{0.9}Yb_{0.1}F₂ are moderately radiation hard Cherenkov radiators. It was also found that the Cd_{0.99}Mn_{0.01}F₂ crystal has a specific light yield of about 20000 photons/MeV. The main de-

excitation time is about 300 μ s, and the maximum of the luminescence spectrum is at about 550 nm. While this crystal cannot be used in high-energy physics due to its large de-excitation time, it may be used to search for double β decay. Figures 5; tables 3; references 20: 5 Russian, 15 Western.

Russia: High-Voltage, Low-Impedance Load Based on Liquid Resistors

964D0184C Moscow PRIBORY I TEKHNIKA
EKSPERIMENTA in Russian
No 4, Jul-Aug 95 pp 73-78

[Article by A. I. Gerasimov, All-Russian Scientific Research Institute of Experimental Physics, Arzamas-16, Nizhegorod Oblast; UDC 621.316.87 (manuscript received 18 Nov 94)]

[FBIS Summary] A load is formed from a large number of autonomous hermetically sealed liquid resistors based on an aqueous solution of salts and acids uniformly distributed around one or several coaxial circles. Loads with a resistance of $\leq 1 \Omega$ and an inductance of tens of nanohertz at a pulse voltage of up to 2.1 MV and a current up to 300 kA are used to simulate tubular beams of electrons in the measurement of volt-ampere characteristics of inductor units in the powerful LIU-30 linear accelerator. The design and parameters of the simulator are presented. The simulator contains 45 liquid resistors and sensors to measure the voltage in the simulator and the current passing through it. Figures 3; references 11: 7 Russian, 4 Western.

Russia: Universal Current Source To Power Pump Lamps of Solid-State Lasers

964D0184D Moscow PRIBORY I TEKHNIKA
EKSPERIMENTA in Russian
No 4, Jul-Aug 95 pp 93-97

[Article by V. V. Togatov, L. A. Mozolyako, A. N. Kutyev, St. Petersburg Institute of Precision Mechanics and Optics; UDC 621.3.316.721 (manuscript received 31 Oct 94)]

[FBIS Summary] A source of current to power the pump lamps of solid-state lasers is formulated using trapezoidal current pulses whose amplitude and duration are independently regulated at 40-800 A and 50-1000 μ s respectively. The amplitude instability is ≤ 5 percent. The pulse front length is 50-200 μ s and the pulse fall time is $\leq 2 \mu$ s. The pulse repetition rate may reach 10 Hz. The maximum pulse power provided by the source to a pump lamp is 500 kW, and the maximum average power is 2.5 kW. The maximum pulse power is a factor of two higher than the Model 883-V generator produced by Analog Modules Inc. Figures 4.

Russia: On the Possibility of Using Microchannel Plates At High Count Rates

964D0184E Moscow PRIBORY I TEKHNIKA
EKSPERIMENTA in Russian
No 4, Jul-Aug 95 pp 102-111

[Article by N. M. Shyutte, E. A. Platov, V. I. Beloglazov, N. B. Skibina, Ye. V. Pluzhnikova, Institute of Space Research, Russian Academy of Sciences, Moscow; UDC 539.1.074 (manuscript received 25 Jan 94; after revision 13 Sep 94)]

[FBIS Summary] This paper studies the output parameters of microchannel chevron-type amplifiers based on two microchannel plates with a conductivity current which varies along the channel, that is, with a "variable" resistance. There is no accumulation of spatial charge at the output of the channels in these plates, and this improves their output characteristics. The current sensitivity of detectors to a change in the intensity of the input flux is increased by several orders of magnitude, and no degradation of the output parameters of the detectors is observed at high output count rates (to several megahertz). The detector stability improves over time at higher output count rates. The use of plates with a "variable" resistance expands the dynamic range of these devices by more than two orders of magnitude while retaining the amplification properties of the device as load increases. Figures 3; references 23: 5 Russian, 18 Western.

Russia: High-Sensitivity Submillimeter Interferometer with an Elliptical Gaussian Beam

964D0184F Moscow PRIBORY I TEKHNIKA
EKSPERIMENTA in Russian
No 4, Jul-Aug 95 pp 117-120

[Article by V. V. Kubarev, G. I. Budker Institute of Nuclear Physics, Siberian Division, Russian Academy of Sciences, Novosibirsk; UDC 533.9.082.74 (manuscript received 28 Feb 94; after revision 29 Nov 94)]

[FBIS Summary] A high-sensitivity submillimeter ($\lambda = 0.337$ mm) six-channel interferometer with an elliptical Gaussian beam is described. An HCN laser is used in the design. The interferometer is designed to measure the radial profile of plasma density (the threshold linear density of the plasma is about 10^{11} cm⁻²) in conditions where, due to the small size of the plasma region, it is impossible to use a sufficient number of discrete chord channels. A spatial resolution of about 1.5 cm is achieved. Figures 3; references 5: 4 Russian, 1 Western.

Russia: Study of the Amplifier Circuits of μ s Dye Lasers with Two-Stage Pumping

964D0184G Moscow PRIBORY I TEKHNIKA
EKSPERIMENTA in Russian
No 4, Jul-Aug 95 pp 130-137

[Article by S. A. Batishche, V. A. Mostovnikov, V. V. Tarkovskiy, B. I. Stepanov Institute of Physics, Academy of Sciences of Belarus, Minsk; UDC 621.373.826.038.824 (manuscript received 1 Aug 94; after revision 9 Jan 95)]

[FBIS Summary] This is a comparative study of the amplifier circuits (single-pass, double-pass, regenerative) of a dye laser with two-stage pumping. The master dye laser and amplifier cascades were pumped with dye laser radiation (with microsecond duration lamp pumping). This method eliminates pumping of the UV and IR components, which leads to strong thermo-optical distortion of the optical homogeneity of the active medium, an increase in divergence of radiation, and a drop in pumping effectiveness. It is shown that in these circuits one can obtain spectrum tunable (550 to 590 nm) pulses of radiation about 1.0 μ s in duration with a divergence of about 10^{-3} rad, a spectral width of about 10^{-3} nm, and an energy of about 0.5 J. Figures 5; references 18: 16 Russian, 2 Western.

Russia: Permanent Magnet Device To Create the Initial Current in Spiral Explosive-Magnetic Generators

964D0184H Moscow PRIBORY I TEKHNIKA
EKSPERIMENTA in Russian
No 4, Jul-Aug 95 pp 138-145

[Article by A. B. Prishchepenko, Central Scientific Research Institute of Chemistry and Mechanics, Moscow; UDC 537.6:621.318 (manuscript received 26 pr 94; after revision 6 Dec 94)]

[FBIS Summary] When an explosive-magnetic generator is used as an autonomous one-time power source, it is expedient to use permanent magnets to create the initial magnetic flux. The magnetic field should be concentrated in the initial portion of the coil where, in this case, the density of turns is greatest, to achieve the maximum magnetic flux. The magnetic field is concentrated in the spiral by superposition of the fields of two types of elements in the magnetic system. Specific design parameters to be considered in the configuration of the magnet system are discussed. A permanent magnet device is described which creates a magnetic flux of 1.3-1.8 mWb within the spirals of explosive-magnetic generators with a diameter of 40 mm and with an initial winding step of 2.1 mm. The most important advantage of this permanent magnet system (when used as an au-

tonomous power source in explosive generators) is the ability to control the initial (and final) power parameters prior to the explosion. Figures 8; references 6: 5 Russian, 1 Western.

Russia: Pre-explosion Conduction of Silver Azide

964D0178A Moscow PISMA V ZHURNAL
EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI
in Russian 10 Aug 95 Vol 62 No 3, pp 203-204

[Article by B.P. Aduyev, E.D. Aluker, G.M. Belokurov, and A.G. Krechetov, Kemerovo State University, Kemerovo; first paragraph is PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI abstract; manuscript received 27 Jun 95]

[FBIS Translated Text] *The conduction of silver azide whisker crystals during a laser pulse-initiated explosion was measured. It was demonstrated that the conduction pulse outpaces the explosion by 50-70 ns, with the study sample's conduction approaching metallic conduction. It was concluded that the process [of silver azide's explosive disintegration] is based on a chain mechanism of explosion.*

Despite the fact that silver azide has for many years been a model object for studying initiating explosives, the mechanism of the explosive disintegration of AgN_3 still remains unclear. It is generally believed that the explosive disintegration is a consequence of the exothermal reaction $2\text{N}_3^0 \rightarrow 3\text{N}_2$ that results in the release of 10 to 12 eV of energy.¹ The question of whether it is a thermal or chain mechanism of explosion that is implemented in silver azide remains unclear, however.^{1,2}

This communication presents the results of experiments in which pre-explosion conduction of silver azide was observed for the first time. In our opinion, the results provide unequivocal evidence that the explosion is a chain explosion.

The conduction of silver azide whisker crystals during a process of explosive disintegration initiated by a neodymium laser (1,060 nm, 30 ps, 3-20 mJ) was studied. Two series of experiments were conducted. In the first series, the study sample was mounted between electrodes in air. The voltage was fed through indium-gallium contacts (3-100 V). The current through the sample and luminescence were measured simultaneously (by an FEU-97 detector with a UFS-1 filter). In the second series, the study sample was attached to a dielectric wafer that was in contact with the acoustic transducer's sensor, which has a resolution of ≤ 10 ns. The current passing through the study sample, luminescence, and acoustic signal were measured simultaneously. The presence of a substrate in the second series of experiments distorted the drop of the conduction

and luminescence pulses; however, it did not affect the leading edge. Strict time referencing of all three study signals was thus possible. The system's response to the initiating pulse (the front of the current pulse from the silicon resistor used instead of the study sample in the case of conduction, the multiplier phototube pulse from the scattered laser light in the case of luminescence, and the pressure pulse from the laser pulse in the case of the acoustic signal) served as a benchmark permitting such referencing. The figure presents the oscillograms that were thus registered for one of the study samples. The

rather long "dead" time preceding the explosion is noteworthy. It ranges from 800 to 20 ns as the energy of the initiating pulse increases from 3 to 20 mJ, with the leading edge of the conduction remaining unchanged. Luminescence of the study sample is observed during the course of the "dead" time and also at the front of the conduction pulse. A luminescence spike is also observed at the fall of the conduction pulse corresponding to the study sample's explosion. This latter spike is evidently due to the plasma formed during the explosion.

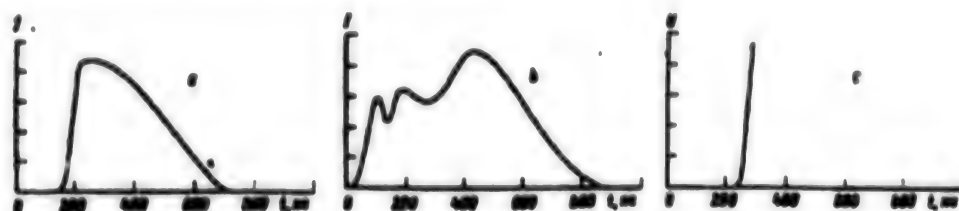


Figure. Current (a), luminescence (b), and acoustic signal (c) of a whisker crystal of silver azide during the process of explosive disintegration initiated by a laser pulse. The zero moment in time corresponds to the signal-recording system's response to the initiating pulse. All values characterizing the signals (j , I , U) are given in relative units.

The following two facts are most interesting.

1. The conduction pulse's front outpaces the acoustic signal by 50-70 ns. The acoustic signal's leading edge coincides in time with the peak current pulse. Because the acoustic signal's front corresponds to the study sample's disintegration, the rising portion of the current pulse is a result of the nondisintegrated current's conduction, which is to say that it may be reliably identified as pre-explosion conduction. The subsequent conduction drop is due to disintegration of the study sample.

2. Measurement of pre-explosion conduction in crystals with different cross sections has demonstrated that the magnitude of the current in the pre-explosion mode is dictated by the contacts' resistance. This makes it possible to estimate the lower bound of the conduction of a crystal in a pre-explosion mode as $\leq 10^9 \text{ ohm}^{-1} \text{ cm}^{-1}$. In other words, in a pre-explosion mode the study sample's conduction approaches metallic conduction. This fact is unequivocal confirmation of the nonthermal nature of the reaction causing the propagation of electron excitations and ultimately leading to the study sample's explosion. In fact, simple estimates demonstrate that given the thermal width of silver azide's forbidden band, i.e., approximately 1.5 eV,³ the observed conduction values correspond to study sample temperatures on the order of several thousand degrees, which is totally unrealistic.

Another fact that we consider to be of fundamental interest is the nature of the pre-explosion state, during which the study sample's geometric dimensions do not yet change significantly (the absence of an acoustic signal) but conduction approaches metallic conduction.

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The authors thank Yu.A. Zakharov, V.I. Krashenin, and V.G. Kriger for their stimulating discussions and L.S. Nesteryuk for preparing the study samples.

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Russia: Pressure-Dependent Conductivity of Fullerene Semiconductor Films

964D0214A St. Petersburg PISMA V ZHURNAL
TEKHNICHESKOY FIZIKI in Russian 12 Aug 95
Vol 21 No 15, pp 15-19

[Article by O. A. Gudayev, V. K. Malinovskiy, L. Mazalov, A. V. Okotrub, E. E. Paul, A. L. Chuvilin, Yu. V. Shevtsov, Institute of Automation and Electrometry, Institute of Nonorganic Chemistry, Institute of Catalysis, Siberian Division, Russian Academy of Sciences, Novosibirsk (manuscript received 16 Feb 95; after revision 27 Apr 95)]

[FBIS Summary] This paper reports on the observed strong dependence of the conductivity of thermally annealed fullerene films on atmospheric pressure at $10^{-1.5} \times 10^5$ Pa. There is no dependence of conductivity on pressure in nonannealed films. Fullerene films were annealed in air at 350-400°C. When placed in a cryostat which was then evacuated, conductivity decreased by more than an order of magnitude. Initial conductivity returned with normal air pressure. It was verified that the effect is not due to the effects of oxygen and water vapor. Unlike the nonannealed sample, no conductivity peak was observed at the orientation phase transition in the annealed sample. The conductivity of the annealed sample was more sensitive to fast pressure changes than slow changes. The density of the film changes with pressure, and is more sensitive to a drastic pressure change than a smooth pressure change. Experiments involving the annealing of fullerene powder revealed that during annealing, fine crystalline fullerene forms a substance similar to bubbles bound in a disordered form. The bubbles are about 1 nm in size, which corresponds to the size of the fullerene molecule. It is assumed that annealing of fullerene films yields the same results as the annealing of fullerene powder. The dependence of conductivity on pressure is found to be due to the change in the density of the substance caused by pressure. Figures 2; references 3: 1 Russian, 2 Western.

Russia: Recording Color Holograms on Monolayers of PFG-03Ts

964D0213A St. Petersburg PISMA V ZHURNAL
TEKHNICHESKOY FIZIKI in Russian 26 Aug 95
Vol 21 No 16, pp 76-80

[Article by G. Von Bally, F. Dreyzen, V. B. Markov, A. Roskhop, E. V. de Khaller, Laboratory of Biophysics, University of Munster, Germany; Institute of Applied Optics, National Academy of Sciences of Ukraine;

Federal Institute of Technology, Lausanne, Switzerland (manuscript received 9 Jun 95)]

[FBIS Summary] This paper studies methods of recording reflective holograms and studying the characteristics of the resultant reflective holograms. Monolayers of PFG-03Ts and PFG-03S have been developed for color holograms. Developing solutions containing pyrogallol were used to obtain the color holograms. Optimal results were obtained with a modified Holodev-602 developer. An important parameter of the developing solution is the balance of concentrations of pyrogallol and Na_2SO_3 . The optimal balance of concentrations was found to be about 0.8-1.0. The concentration of pyrogallol was reduced by 15-20 percent compared with the initial formula. The total concentration of developer was half the recommended amount, and the developing time was increased to five minutes at 22°C. The plates were whitened in a solution of PBQ-arnidol (three to five minutes, 22°C) with subsequent rinsing in running water and drying under natural conditions. The diffraction effectiveness was 65-75 percent for each wavelength. An examination of the spectral selectivity reveals uniform processing of the entire thickness of photo layer. This method of processing the photo layer makes it possible to obtain high-quality color holographic images with a low noise level. Figures 2; references 10: 4 Russian, 6 Western.

Russian Research on Nuclear-Pumped Lasers Described

964D0172A Moscow PRIRODA in Russian Sep 95
No 9, p 3-15

[Article by Sergey Ivanovich Yakovlenko, doctor of physical and mathematical sciences, professor, and department head, Kinetics Department, General Physics Institute, Russian Academy of Sciences: "Nuclear-Pumped Lasers: Dream or Reality?"]

[FBIS Translated Text] Both nuclear reactors and lasers are the engineering embodiment of the most impressive achievements of physical science in the 20th century. In both Russia and America work is now under way to create a nuclear-pumped laser, i.e., a unit that will not just produce thermal energy transformed into electricity but will also directly produce coherent radiation. Surprisingly, Russia remains in first place in the field.

Looking Back

As is well known, a laser is a device that transforms the energy (generally electrical, light, or chemical energy) input into the energy of coherent light-range electromagnetic radiation. The energy is input into what is termed the laser's active medium, and as a result of the input (generally referred to as pumping), the medium acquires the ability to amplify light. Because of its unique properties, especially its monochromaticity and

low beam spread (high coherence), laser radiation immediately found diverse applications in physics research and later in industry.

Virtually immediately after the first lasers were fired in the 1960s, various proposals regarding pumping the active medium with nuclear reaction products appeared in print. In the days of the rise of laser physics, the firing of each new type of laser and each new pumping method were causes of joy. The goal was to have lasers with as many different types of capabilities and power outputs as possible. Nuclear pumping, i.e., excitation of the active medium with the fast fragments developing in nuclear reactions, was viewed as a means of creating a high-power laser. In the 1970s, nuclear-pumped lasers were fired—where and by whom will be discussed below. First, several questions that constitute the basis of the problem will be examined. It should be stated from the outset that this article will not discuss pumping the laser medium with a nuclear explosion but will instead discuss reusable units. Lasers that are pumped by a nuclear explosion have their own unique properties and are best discussed separately.

The question of nuclear pumping of a laser's active medium may be formulated in a fundamentally different way: whether to view such a laser not as a way of creating a high-power laser but rather as a way of extracting the energy of a nuclear reactor and as a possible way of directly converting nuclear energy into light energy. This in turn leads to the idea of a fundamentally new type of device: the laser-reactor. The laser-reactor should house both the laser's active medium and the reactor's core. The approach opens up the possibility of a qualitatively new type of power generation. One would like to dream of wireless energy transmission over distances of cosmic proportion, of mankind using light energy as laser energy is used, and so forth.

Many specialists in the field of laser physics have apparently thought of creating a laser-reactor. Each has done so in his own way. Some have obviously not taken the idea seriously, while others working in restricted organizations cannot publish. L.I. Gudzenko and I came up with the idea of a general conception of a plasma laser with a rigid ionizer. We have not only been able to publish our ideas but also to "push through" a patent application titled "Laser-Thermal Extraction of Energy From a Nuclear Reactor." In my view, those general principles have not yet become obsolete. As in our previous publications, our additional discussions will proceed from the physics of processes occurring in lasers' active media.¹

Gas and Plasma Lasers

All lasers are a thermodynamically nonequilibrium system, inasmuch as a thermodynamically equilibrium medium is incapable of amplifying electrodynamic radiation. Amplification of light becomes possible if the energy levels are populated inversely: the density of the particles (for example, atoms) in the upper working state must be greater than in the lower working state. When photons propagated along the active medium encounter an atom in the upper working state, an induced transition occurs: the photon is generated nearly identical to the photon that gave rise to it, as a result of which two photons are formed. The photons are absorbed if they encounter atoms in a lower energy state. In thermodynamic equilibrium, the population of the lower levels is always greater and light is predominantly absorbed. During a population inversion, a photon will most often encounter an excited atom, and an avalanche-like increase in the number of photons occurs.

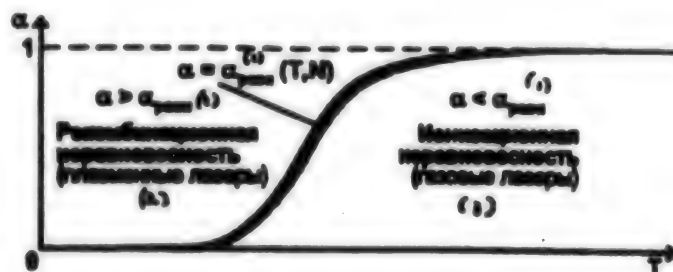


Figure 1. Nonequilibrium active medium and different types of lasers. α = degree of ionization of the plasma or ratio of the number of ions to the total number of heavy particles in the medium; 1, α_{eq} (degree of ionization in a state of thermodynamic equilibrium given the specified temperature $[T]$ and density (i.e., the number of heavy particles per unit volume) $[N]$ of the medium; 2, recombination nonequilibrium (plasma lasers); 3, ionization nonequilibrium (gas lasers).

Of course, lasers based on ionized gases (i.e., plasma) also require a population inversion. However, departure of the plasma from a state of thermodynamic equilibrium may occur in, so to speak, different directions (Figure 1). In a mode of recombination nonequilibrium, various recombination reactions of the ion with the electron cause the latter to end up in a highly excited state. Collisions with the electrons of plasma and other particles will then drive the electron into lower energy states. This set of transitions is termed recombination flow. Ionization relaxation and, consequently, an ionization flow occur because of exciting collisions of the bound electrons with the electrons of the plasma. In plasma whose electrons are of a lower density than what would exist in a state of thermodynamic equilibrium at the given temperature, processes of ionization and excitation of the medium's atoms and molecules predominate.

Such plasma is superheated because the temperature in it is higher than the temperature that would exist given an equivalent degree of ionization. The relaxation flow along the energy levels proceeds from the bottom up (Figure 2), and if a number of conditions are met, the working levels are populated inversely. The opposite situation, where the plasma is supercooled, is also possible, however. Such plasma contains more electrons than there would be in a state of thermodynamic equilibrium, and the temperature is lower than that with the given degree of ionization in equilibrium. Different processes of recombination of electrons with ions resulting in the formation of neutral particles (atoms and molecules) predominate in such plasma. In supercooled plasma, the relaxation flow proceeds from the top downward and may also lead to a population inversion.

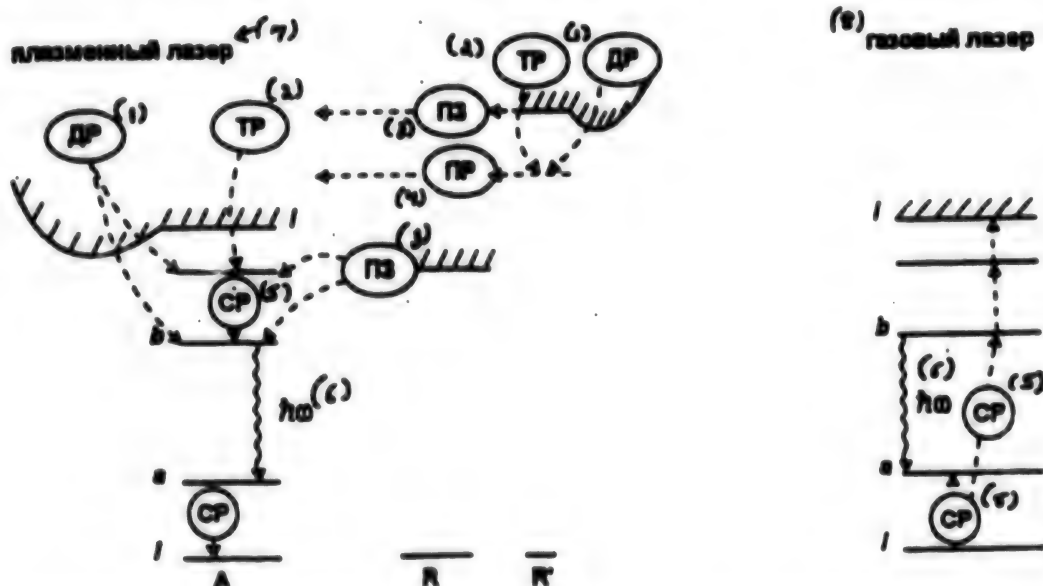


Figure 2. Diagram of relaxation flows in supercooled (left) and superheated plasma. A , working atom; R and R' , buffer gas atoms; a and b , lower and upper working levels; 1, dissociative recombination; 2, triple recombination; 3, recharging; 4, Penning reactions; 5, collision relaxation; 6, quantum energy of the working transition; 7, plasma laser; 8, gas laser.

At the same time, when the idea of creating lasers based on supercooled plasma was first proposed and began to be developed, the ideology of lasers based on superheated plasma reigned supreme and were termed gas lasers. The group of theoreticians who had developed the concept of lasers based on supercooled plasma began calling them plasma lasers so as to differentiate the lasers that had not yet been created from existing lasers.

Of course, such a classification is arbitrary, as are all classification systems. For example, there is generally no one temperature for electrons and heavy particles, and even the concept "electron temperature" cannot always be used because of the nonequilibrium nature of the function characterizing the electrons' distribution by energies. Often, the relaxation flow for some excited states is determined by collisions with electrons, whereas for others it is determined by collisions with

heavy particles. However, this type of "thermodynamic" approach makes it possible to reflect the qualitative differences of the active media of lasers based on plasma. These differences are significant for both the theory and experimental implementation of a population inversion in such "thermodynamically opposite" media. For example, the location of energy levels convenient for an inversion in a mode of excitation from the ground state does not generally lead to an inversion in a recombination mode or vice versa.

What is most significant for the set of issues under discussion here is the fact that the methods of forming active media in plasma and gas lasers differ radically from one another. For example, while pulse gas lasers generally operate at the pulse front of an electrical field that is growing hot, plasma lasers generally operate in an afterglow when the field has been switched off and the electrons have had time to cool. Achieving a steady state in a gas laser generally requires bulk heating of the free electrons when they are in a comparatively low concentration limited by transfer from the discharge area to the periphery where recombination is occurring. A steady-state plasma laser, on the other hand, requires bulk cooling of the electrons with an elevated degree of ionization created by an external source.

Rigid Ionizer

The number of methods currently being used to pump active media is rather large. The following methods are among those that have gained the widest popularity: different forms of gas discharge, electron and ion beams, nuclear pumping, and pumping by electromagnetic radiation.

Regardless of the method used to pump the medium, the working gas is transformed into plasma provided that a sufficient power density has been provided. Nearly all the methods may tentatively be classified as one of two types depending on the type of plasma ionization state achieved during the course of the pumping: thermal ionization and pumping by a rigid ionizer. Thermal ionization is characteristic of the overwhelming majority of forms of gas discharge in which the energy from the electrical field is transferred to the electrons in small portions (within the electron's free transit time), after which there occurs a process of thermal ionization during which, as has already been mentioned, the plasma becomes superheated. In the case of pumping with a rigid ionizer, the sequence of processes is reversed: a fast charged particle or shortwave photon ionizes the gas, and the low-energy plasma electrons that are ultimately formed assume a Maxwellian distribution in collisions and recombine. Such plasma turns out to

be supercooled. We will examine this process in more detail.

Corpuscular or electromagnetic radiation that ionizes and excites gas but weakly interacts directly with the free electrons of the resultant plasma is generally termed rigid. More specifically, what is being referred to are electrons and ion beams, fragments of nuclear reactions, and flows of shortwave photons (all the way to the γ -quanta obtained in a nuclear explosion). It is as if the "rigid particles" (electrons, ions, photons) "pull" the electrons from the atoms' ground state, thereby creating plasma with an elevated degree of ionization. The physics of the effect of all these energy carriers on the gas is largely identical. The point is that if a charged particle's movement in a medium is sufficiently rapid, the cross sections of its inelastic collisions with the atoms of the gas will depend only on the particle's velocity and the properties of the atom and not on mass. Therefore, when the velocities of an electron and ion are equal, the effectiveness of their excitation and ionization of the medium is identical. When a medium is ionized by rigid photons, their absorption will result in the generation of fast electrons, after which the ionization process develops nearly the same when the medium is subjected to the effect of an electron beam.

The following facts are important to the physics of nuclear pumping. The neutron-stimulated nuclear fragments formed in nuclear reactions have enormous (compared with atomic electrons) kinetic energies, which means that they also have velocities significantly greater than those of atomic electrons. Furthermore, the very act of nuclear fission lasts only a very short time (compared with atomic scales). It is as if nuclear fragments "shake off" their electrons and mix in the gas because they are already ions.

In general terms, the formation of plasma in dense gas under the effect of fragments from nuclear reactions may be explained as follows (Figure 3). Approximately half of all electrons developing as a result of impacts with rigid particles have sufficient energy to reionize or excite gas. The ionization process dictated by both primary particles and secondary electrons is generally termed an ionization cascade. Electrons that have lost so much energy in inelastic collisions that they no longer have enough energy to excite atoms (subthreshold electrons) are further cooled when they collide with neutral molecules on account of elastic collision in inert gases and excitation of vibration-rotation degrees of freedom (provided that a sufficient quantity of molecular impurities is present). For electrons cooled to an energy of approximately several thousand degrees, even electron-electron collisions shaping a Maxwellian distribution of the plasma's electrons are significant.

Their density is several orders of magnitude greater than that of electrons in other energy groups (subthreshold electrons and electrons of an ionization cascade). It is the electrons of plasma that generate a recombination flow along excited states. It is now clear that lasers with nuclear pumping are plasma lasers.

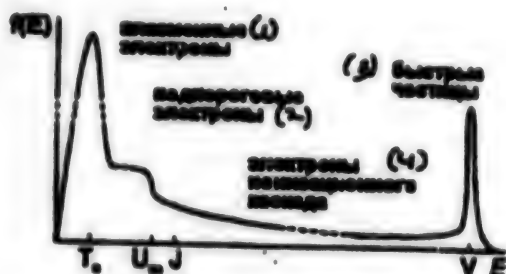


Figure 3. Qualitative pattern of the energy spectrum of electrons during ionization and excitation of dense gas by a rigid source. V = energy of fast particles; T_e = temperature of the plasma electrons; J , ionization energy of the medium's atoms; U_m , excitation threshold of the medium's atoms; 1, plasma electrons; 2, subthreshold electrons; 3, fast particles; 4, electrons of the ionization cascade.

Laser With Nuclear Pumping

The range of a nuclear fragment is rather low: It amounts to microns in a condensed medium and centimeters in gases of atmospheric density. Accordingly, a nuclear-active substance must either be mixed with a laser-active mixture or else applied in a thin layer (several milligrams per square centimeter) onto the surface of tubes (laser cells) containing ionized gas. Both methods have been implemented. ^3He is generally used as a nuclear-active gas. Sometimes uranium hexafluoride is used, ^{10}B , uranium (IV-VI) oxide, or plutonium dioxide generally serves as a solid-state coating.

The laser cells are irradiated with an external flow of neutrons (Figure 4). As is well known, slow (so-called thermal) neutrons with an energy on the order of room temperature are most effective in nuclear reactions. The strongest flows may be achieved in the form of fast neutrons from pulse reactors. Consequently, if not oriented to explosion pumping, fast neutrons must be

cooled in a moderator before irradiation of the laser cells.

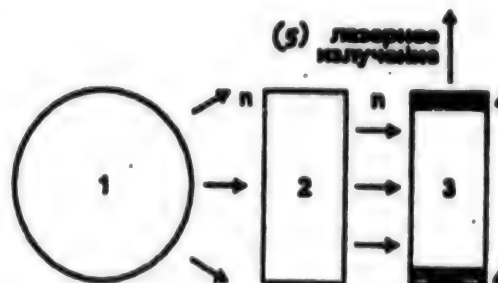


Figure 4. Diagram of a laser with nuclear pumping. 1, pulse reactor (neutron source); 2, neutron moderator; 3, tube with working gas; 4, mirrors; 5, laser radiation; n = neutrons.

Actualizing this comparatively simple design of a laser with nuclear pumping is fraught with an enormous number of what may be termed experimental difficulties. It is impossible to mention them all. Suffice it to say that firing a laser with nuclear pumping requires a scientific-engineering base permitting the following: working in a setting that poses a radiation hazard, manufacturing thin coatings, conducting spectroscopic studies, purifying the gas until a high degree of purity is achieved, and so forth. The main problem is that access to a powerful pulse neutron source is required. Such sources have only been developed for military purposes in restricted organizations.²

The first nuclear-pumped lasers were fired at the All-Union Scientific Research Institute of Experimental Physics [now the All-Russian Scientific Research Institute of Experimental Physics] in Arzamas-16 in 1972 (Figure 5); however, the results could only be published 7 years later.³ It is therefore generally believed that the first successful experiments examining nuclear pumping were conducted in Sandia National Laboratory in the United States.⁴ The lasing was achieved on the basis of infrared transitions of a xenon atom mixed with helium. It should be noted that associates at the All-Russian Scientific Research Institute of Experimental Physics traveled the long road from nuclear pumping of condensed media to plasma lasers.

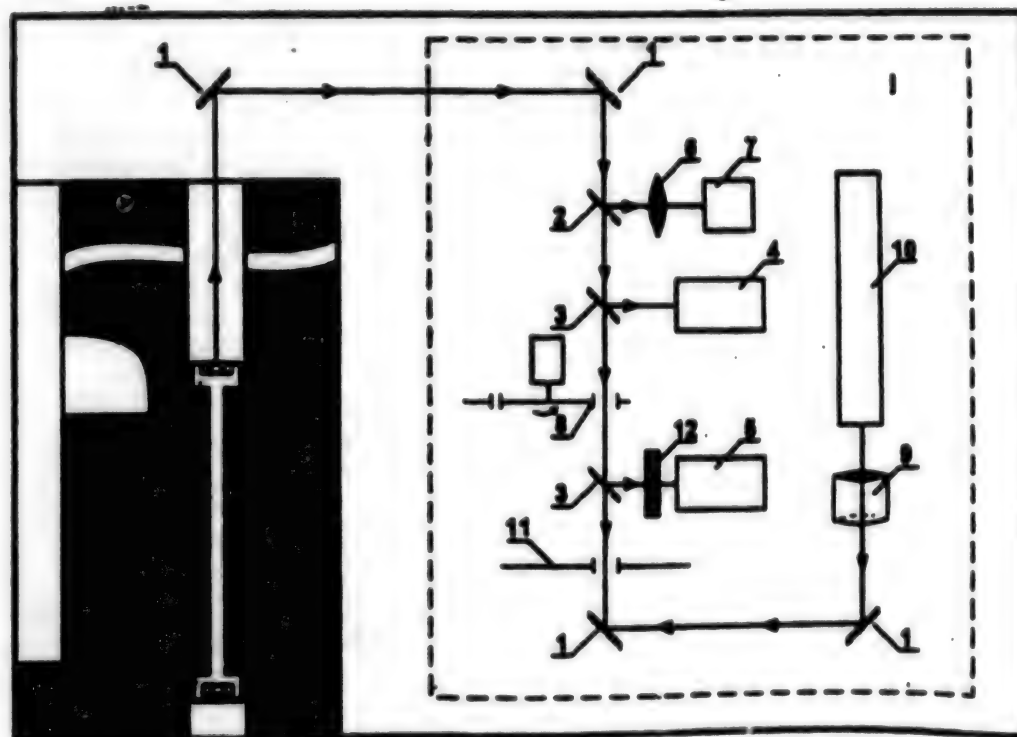


Figure 5. Diagram of an experiment examining nuclear pumping of a laser based on an He-Xe mixture that was conducted in a VIR-2 reactor. I, system to record the laser radiation's parameters; II, nuclear-pumped laser based on an He-Xe mixture; III, reactor's core. 1, turning mirror; 2 and 3, dividing plates; 4 and 5, photoreceivers; 6, focusing lens; 7, energy meter; 8, modulator; 9, collimator; 10, aligning laser; 11, diaphragm; 12, light filter.

The world's first nuclear-pumped laser operating in the visible range was also fired in Russia in 1979.⁵ It was based on transitions of a cadmium ion in a mixture of its vapors with ^3He (Figure 6). In 1985, it was once again Russia who fired the first nuclear-pumped

laser based on a mixture of inert gases (helium and neon with impurities). Published reviews⁶ provide some information about the development of experimental research on nuclear-pumped lasers based on metal vapors and inert gases.

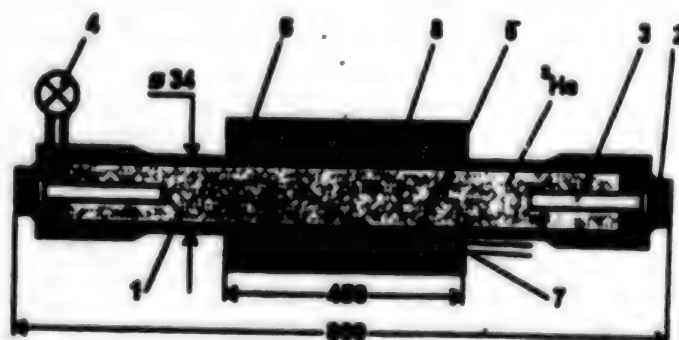


Figure 6. Design of the first ^3He -Cd laser with nuclear pumping: 1, quartz tube; 2, mirror; 3, protective tube; 4, isolator; 5, cadmium source; 6, electric furnace; 7, thermocouples; 8, neutron moderator.

To date, nuclear pumping has been achieved for more than 35 transitions of atoms and ions of seven chemical elements in the range of wavelengths from 3.51 to 0.442 μm . Basic experimental research is being conducted through the joint efforts of two Russian Federation nuclear centers: the All-Russian Scientific Research Institute of Experimental Physics (VNIIEF in Arzamas-16) under the supervision of A.M. Voinov and A.A. Sinyanskiy on VIR-2 and 2M, TIBR-1M, and VIGR reactors and in the All-Russian Scientific Research of Engineering Physics (VNIITF in Chelyabinsk-70) under the supervision of E.P. Magda on an EBR-L reactor. A team of associates from Moscow Physics Engineering Institute (MIFI) is making a big contribution. Under the direction of A.I. Miskevich, the team is conducting spectroscopy studies on a reactor at the institute and is also conducting out-of-town lasing experiments in Arzamas and Chelyabinsk. Scientists at the Kinetics Department of the General Physics Institute (IOF) of the Russian Academy of Sciences are developing theoretical models of active media of lasers with rigid pumping (nuclear pumping in particular). I will mention that from the standpoint of both experimental results and the level of theoretical development of the problem, the research being conducted in Russia is far ahead of analogous research under way in the United States, as was openly acknowledged by Sandia's representatives at a conference on nuclear-pumped lasers that was held in autumn 1994 in Arzamas-16.

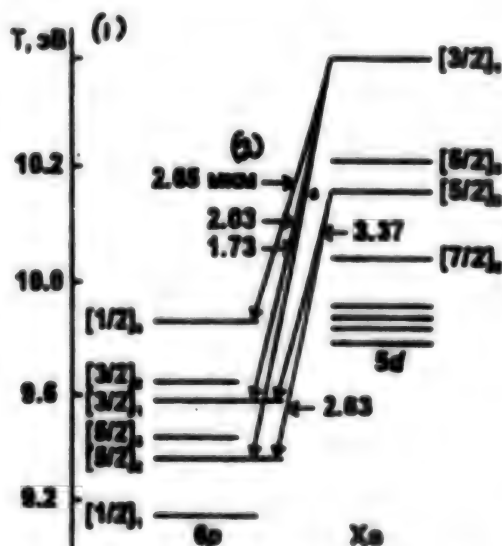


Figure 7. Diagram of laser transitions in a xenon atom. Key: 1, T, eV; 2, μm .

The best power generation characteristics have been achieved in lasers based on transitions of a xenon atom (Figure 7): The power level of the laser radiation produced reached 1-2 kW with a per-pulse energy of 1-2 J and an efficiency in input energy of 0.6-0.8 percent. The best efficiency values achieved for a nuclear-pumped xenon laser reached 2 percent (at a wavelength of 1.73 μm). Very low lasing thresholds (approximately 40 mW/cm² with neutron fluxes of approximately 3×10^{12} particles/cm²/s at a lasing wavelength of 2.63 μm) were achieved in it. A xenon laser with pumping of the active medium through the nuclear-active zone (lasing duration, 1-1.5 s; pulse energy of 40 J) has been implemented.

When these data are compared directly with analogous characteristics of electric discharge lasers and electron beam lasers, the power generation capabilities of nuclear-pumped lasers still seem modest; however, consideration must be given to the enormous size of nuclear power generation units (with allowance for their bioshield), the complexity of working in a setting posing a radiation hazard, the sparseness of laser pulses (no more than several times per day), and the fact that the infrared range is much less interesting than the visible range is. In this context, we will discuss the main physical factors limiting nuclear-pumped lasers' power generation and other capabilities.

Threshold Pumping of Laser Active Media

As has already been mentioned, many physical processes occurring in active media pumped with electron beams and many fragments are identical. (Some differences may arise if the ionization media from different nuclear fragments do not overlap; however, the said situation only occurs in cases of very weak pumping that are generally inadequate for pumping lasers.) One and the same kinetic models are therefore frequently used for mathematical description of the operation of beam lasers and nuclear-pumped lasers. Furthermore, experiments involving beam pumping may be purposefully conducted to model the properties of an active medium pumped with nuclear fragments. The main difference between the physics of the active media of nuclear-pumped laser and those of beam lasers is as follows. If not oriented toward explosive destruction of the nuclear-active zone, existing neutron sources can only provide a very low specific active medium-pumping power. The said power reaches values on the order of several kilowatts per second per cubic meter with slow-neutron flux densities of approximately 10^{16} to 10^{17} particles/cm²/s. Such an energy contribution corresponds to an electron beam with a very moderate current density of approximately 0.1 to 1 A/cm².

Obtaining much higher neutron flux densities is a complicated matter for several reasons. In a nuclear fission reaction, heavy nuclear fragments entrain most of the energy, with less than 10 percent going to neutrons. Consequently, in a reactor fuel, for each neutron produced a large amount of energy must be removed to avoid an explosion. More precisely, the possibilities for releasing this energy (and consequently, for obtaining neutrons) are limited by the heat capacity of the nuclear-active element that is the neutron source. Furthermore, the fraction of a neutron flux that is used to pump lasers is very small compared with the total number of neutrons produced in a reactor. For example, when several hundred megajoules of thermal energy is released in a reactor serving as a neutron source, only several tens of joules of laser energy will be obtained. The heating of the moderator, where neutrons with an energy on the order of 1 MeV are cooled to thermal neutrons (approximately 0.05 eV), and finally, the fact that only 20-25 percent of the energy of the nuclear fragments obtained in a reaction stimulated by an external neutron can successfully be added to the active medium should also be kept in mind. Finally, focusing neutrons is a complicated matter. All of these factors sharply limit the neutron flux density and, consequently, the specific laser-pumping power. The limited specific pumping power sharply narrows the choice of active media available for nuclear pumping. We will examine the problem in greater detail.

As is well known, generating laser radiation requires not only that an inversely populated (amplifying) medium be produced but also that a rather high gain factor (i.e., high amplification of the radiation per unit length) be provided. If the gain factor is rather large and if the intensity of the radiation throughout the entire length of the active medium increases so much that the increase surpasses the losses in the reflecting mirror, generation of radiation or a lasing effect will occur. In other words, given an active medium with a specified length and specified mirror reflection coefficients, a specific power of pumping the active medium is required that is at least equal to some minimum level required for the population of the upper working level and the gain factor to be large enough for lasing to occur.

The concept "minimum threshold pumping power density" may be introduced. It is weakly dependent on the nature of the processes occurring in the active medium; it is determined first and foremost by the properties of the optical transition between the working levels and radiation losses in the resonator cavity. The said quantity characterizes the theoretical minimum pumping power density that must a priori be exceeded in order for lasing to occur in a given transition. It may be demonstrated that the minimum threshold pumping power density is

proportional to the following: the energy of a photon of amplified radiation; the effective spectral linewidth of the laser transition; and that fraction of energy that is lost when the light from the mirror is cooled. At the same time, it is inversely proportional to the following: the square of the wavelength of the amplified radiation, the length of the active medium; and the pumping efficiency (i.e., that fraction of the recombination flow flowing through the upper working level).

The following three groups of laser transitions may be identified from the standpoint of minimum threshold pumping power density:

- in the visible range in atoms and atomic ions (approximately 10^3 to 1 W/cm³);
- in the visible and ultraviolet regions between the molecules' electron therms (approximately 10^3 - 10^4 W/cm³);
- in multiply charged ions, i.e., transitions corresponding to the vacuum ultraviolet and x-ray ranges (approximately 10^6 to 10^{10} W/cm³).

The low threshold values of lasers operating in the infrared and visible ranges are due to the fact that good mirrors exist for this region of the spectrum, and a rather long active medium (approximately 1 m) may be provided in view of the comparatively low pumping power density.

The significantly higher threshold pumping values for lasers based on molecules' electron transitions are due to the large spectral width of the molecular bands. The most powerful lasers operating in the visible and ultraviolet ranges are those operative on photodissociative transitions of complexes. They are termed exiplex and eximer lasers. Photodissociative transitions are characterized by a very large linewidth that is approximately five orders of magnitude larger than the Doppler width for the visible range. Furthermore, the working transitions of exiplex lasers generally lie in the ultraviolet and vacuum ultraviolet ranges, where mirror quality is poorer than in the visible range.

The large threshold pumping values of lasers at the transition to the shortwave range are due to the fact that the requirements regarding minimum pumping power density increase in a manner inversely proportional to approximately the fourth power of the wavelength (the threshold power is inversely proportional to the square of the wavelength; in addition, the quantum energy of the amplified radiation and Doppler linewidth increases). The situation is further complicated by the fact that in the far ultraviolet range there is no point in considering mirrors and a mode of resonatorless amplification of spontaneous radiation must be kept in mind.

It is clear from the aforesaid rather general remarks that the following types of media can in principle be considered for nuclear pumping:

—short-wave lasers based on transitions of multiply charged ions can only be fired from pumping initiated by an explosion;

—lasers based on halides of inert gases are at the limit of the capabilities of nondestructive neutron sources;

—in fact, only low-threshold active media in the visible and infrared ranges based on atomic and ionic lines are suitable for nuclear-pumped lasers. And it is precisely such lasers that have been implemented.

On the Road to Creating a Nuclear-Pumped Laser

It is evident from the aforesaid remarks that in practical applications (with the possible exception of narrowly specialized applications), lasers with nuclear pumping can hardly compete with conventional lasers in view of the high energy cost of the neutron if it is produced in an external source. The fact that realization of direct nuclear pumping is a step toward creating a laser-reactor is of fundamental importance.

There is no doubt as to the possibility of creating an atomic laser-reactor, inasmuch as no fundamental limitations are evident. Moreover, the latest experimental studies have directly confirmed such a possibility. Nevertheless, simultaneously satisfying all the requirements of lasing and providing the conditions required for sufficiently efficient neutron multiplication in a nuclear reactor are rather difficult. We will discuss the most significant difficulties.⁹

Above all, we should mention the difficulty of creating a laser-reactor based on wideband (especially exiplex) lasers. The problem is that in view of the required high-power specific pumping of such lasers, even the energy release in the moderator turns out to be too great. And it is difficult to use metal vapors in the pumping system, i.e., in the system purging the working mixture. Attention should be focused first and foremost on inert gases.

At first glance, reactors powered by gas-phase fuel appear best suited as the basis of a laser-reactor. In such a case, a significant fraction of the energy of the nuclear fragments is expended to pump the laser-active medium rather than to heat the laser elements' walls. However, practically the only uranium compound that is a gas under normal conditions is uranium hexafluoride (UF_6). Because of its high chemical activity and comparatively low optical transparency, the possibility of achieving a population inversion and amplification on atomic lines in it is sharply reduced. Uranium hexafluoride effectively destroys the upper working state of the atoms

of the active medium; therefore, its density must be low ($< 2 \times 10^{17}/cm^3$). Calculations have demonstrated that the upper bounds imposed on the density of UF_6 by the conditions of lasing are contradictory to the conditions of the reactor's criticality with respect to neutrons. More precisely, fulfilling the conditions of the reactor's criticality with respect to neutrons in the case of a low density requires a bigger reactor (20 m), in which case it is impossible to obtain an amplifying medium inasmuch as photons are effectively absorbed in UF_6 .

Creation of a laser-reactor based on pulverized fuel, i.e., aerosols, suspensions of solid fuel particles, and so forth, does not yet appear possible. Because of the requirements regarding the reactor's criticality, the density of the fuel particles must be higher, which means that the medium will be nontransparent.

The fundamental possibility of creating laser-reactors based on uranium vapors has not yet been considered in detail. It is clear from the outset, however, that the requirement of a high vaporization temperature (approximately 45,000 K) sharply limits the choice of laser-active media.

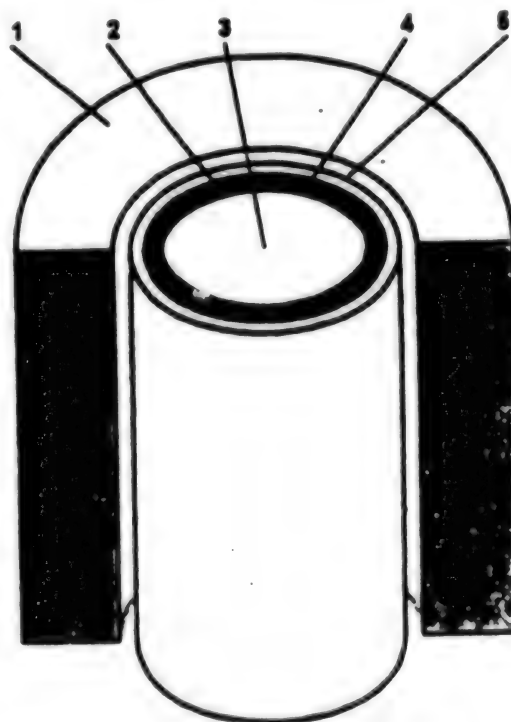


Figure 8. Diagram of the single channel of a laser-reactor: 1, moderator; 2, layer of nuclear fuel; 3, laser-active gas; 4, metal tube of the laser channel; 5, channel filled with coolant to cool the moderator.

As of now, the most realistic type of laser-reactor appears to be that in which the critical mass of the fissile material is assembled from thin foil (Figure 8). Calculations of neutron physics, thermal physics, and thermomechanical parameters⁹ have demonstrated that it is possible to create a steady-state laser-reactor with a capacity of 150 MW and with conversion of up to 0.5 percent of that power into light energy. A mixture of helium and xenon would naturally be used as the laser-active component.

Significant experimental progress has been achieved in this direction. to demonstrate the possibility of creating steady-state self-contained laser-reactors, a multicomponent laser module (the LM-4, Figure 9) has been developed at the All-Russian Scientific Research Institute of Engineering Physics. It operates on the basis of a BIGR

reactor in a pumping mode under conditions achieved in the cores of conventional power reactors at nuclear power plants. Operation of the said type of multicomponent nuclear laser device with a lasing pulse duration of 1-1.5 seconds was demonstrated in 1994. The lasing parameters turned out to be close to those anticipated, which indicated the correctness of both the physics principles and technological decisions underlying the design of continuous-type power laser-reactors. The possibility of creating nuclear-pumped lasers in the core of conventional nuclear power plants may now be considered on the basis of the said developments. Plans for the next stage include designing a multicomponent nuclear laser device in which the critical mass of the fissile material is concentrated in thin foils on the inner surface of the energy-releasing elements.

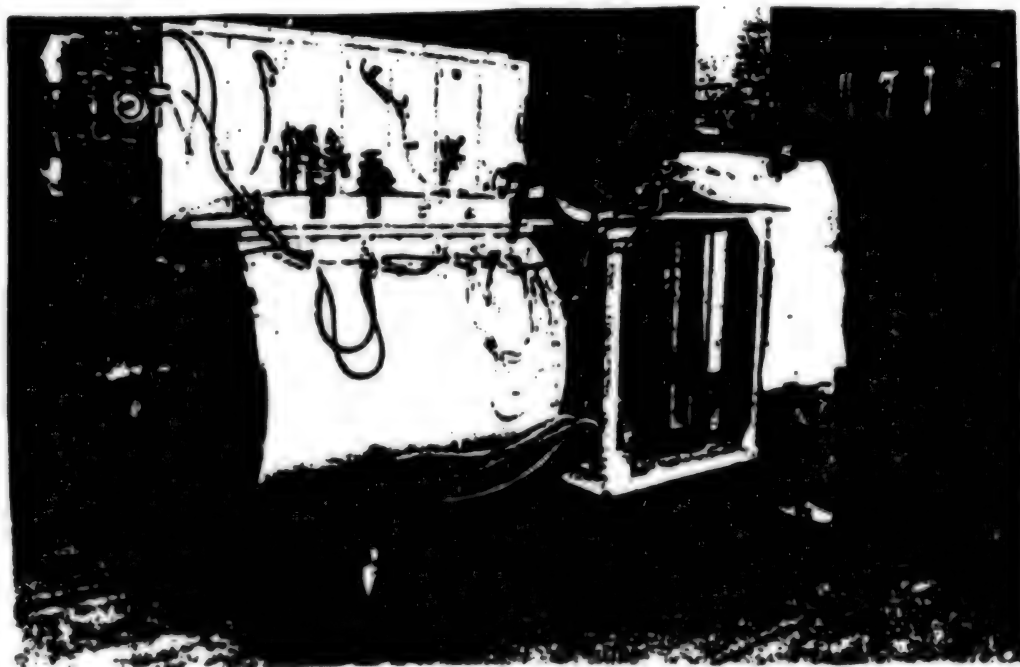


Figure 9. Overall view of the LM-4.

Thus experiments examining the creation of laser-reactors seem to have moved to the finish line, and only adverse outside interference (for example, a cutoff of funding) can keep the goal from being reached.

What's Next?

And so, assuming the normal development of events, a laser-reactor will be created in the upcoming decade. It is still early to beat the kettledrums and paint a future of rainbows, however. Now is the time to think

about the main directions for further development of laser-reactors, specifically about the possible concrete applications of such devices. Otherwise laser-reactors will be something akin to a monument to a not entirely sensible waste of human effort in the fashion of giant tokamaks.

The problem is that it is rather difficult to find a use for the future device (in the form that its loops are now being drawn). More precisely, no job is envisaged for it that could not be accomplished by using other

lasers or by taking some other route. How such a laser-reactor would be better than a powerful gas-dynamic or electric discharge laser is incomprehensible, for example. Would it not be simpler to convert nuclear energy to electrical energy in the conventional manner and then transform the electrical energy into laser radiation or to set up a gas-dynamic laser that is heated by a reactor? When these research projects were begun, no deep thought was given to using laser-reactors because it was not yet clear whether such a device could indeed be created or what the capabilities of such a device would be if one could indeed be created. Now, however, if the matter is to be taken seriously, the directions of further research must be specified more clearly.

As was clear from the very beginning, the general consensus is in favor of developing light power generation. It is clear that laser radiation bears a higher-quality energy than the heat into which nuclear energy is converted in a conventional reactor. Laser energy may in principle be used in the most diverse ways: from remote powering of an internal combustion engine by light (just such a light motor was operated at the end of the 1970s at the General Physics Institute of the Russian Academy of Sciences) to photochemistry. However, the existing laser-reactor designs are apparently not very prepared for this type of application.

The most promising application for laser-reactors appears to be in energy-intensive photochemistry on commercial scales, i.e., to stimulate diverse photochemical reactions (both surface and bulk reactions). The main shortcoming of similar units is that they produce energy in the form of infrared radiation, whereas the most promising types of energy for photochemistry are visible and ultraviolet radiation. Consequently, it will either be necessary to learn to efficiently convert infrared radiation to the visible range on commercial scales (i.e., to work with light energy in the way that we now work with electrical energy) or else to look at the possibility of firing laser-reactors operating in the visible range.

In my view, the most significant obstacle is that the best laser-active medium for laser-reactors has yet to be found. Of course, a medium that could compete with a xenon laser from the standpoint of threshold and output energy characteristics and that would be just as convenient for the pumping loop but that would yield radiation in the visible range may never be found. As far as I know, however, no sufficiently serious comprehensive search for active media for laser-reactors has yet been conducted. In any case, there is still hope of success.

Let us focus our attention on the fact that research to find new laser-active media geared toward laser-reactors should be conducted by using various electron beams for the pumping. It is natural to use wide-aperture beams with a duration of several hundred microseconds to study the processes occurring in nuclear-pumped lasers' active media. Of course, the experiments should be accompanied by reliable mathematical modeling. Research on beam pumping of the active media of plasma lasers is now being conducted at the High-Current Electronics Institute (ISE, Tomsk), and research on numerical modeling is now being conducted at the General Physics Institute of the Russian Academy of Sciences. However, there is no funding for these research projects despite the fact that funds have been found to support doomed-to-fail efforts to create a pulse laser-reactor to trigger controlled thermonuclear reactions."

In conclusion, several statements that follow from the aforesaid material remain to be formulated.

1. The most important steps toward firing nuclear-pumped lasers and creating laser-reactors continue to be made in Russia.
2. The odds are that the first laser-reactor will be created during the course of the upcoming decade.
3. Finding specific methods of using the light energy of laser-reactors requires scientific research of a basic nature and a great deal of scientific-technical work.

Footnotes

"Research on lasers with nuclear pumping is still being conducted at the Power Engineering Physics Institute (FEI, Obninsk). To date, however, there have not yet been any communications about the firing of nuclear-pumped lasers there.

"I will mention one reason why the research on nuclear pumping was not immediately supported by experiments involving electron guns. In the Ministry of Medium Machinebuilding, so-called fissile materials, which account for most of the cost of experiments involving reactors, were entered on separate books—virtually charge free. It was therefore not financially profitable to set up more expensive electron beam experiments. The situation may now be changing inasmuch as the stockpiles of free fissile materials are coming to an end.

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Russia: Possibility of Controlling Growth Mechanisms of MBE High Temperature Superconducting Films

964D0192A St. Petersburg ZHURNAL
TEKHNICHESKOY FIZIKI in Russian Sep 95
No 9, pp 161-170

[Article by V. V. Mamutin, Ioffe Physicotechnical Institute, Russian Academy of Sciences, St. Petersburg (manuscript received 14 Jun 94)]

[FBIS Summary] Several models of molecular beam epitaxy (MBE) growth are analyzed in the acquisition of high-temperature superconducting films. The basic criteria for the control of growth mechanisms are determined. Growth rate has a decisive effect on the crystalline perfection of films. It is shown that there is no epitaxy temperature that is independent of growth rate. When various theoretical models and experimental data are compared, it is found that MBE growth using co-evaporation with a growth rate of 0.01-0.1 Angstroms/s at 400°C under the author's experimental conditions is a two-dimensional growth mechanism (layer by layer), and a three-dimensional (multilayer) mechanism is ruled out. It is possible to control the growth mechanism and select the optimal MBE growth conditions to obtain perfect crystalline high-temperature superconducting films at extremely low temperatures (400°C and below). References 40: 2 Russian, 38 Western.

Russia: Controlled Texturing of High-Temperature Superconducting Materials: Technology, Properties, and Use To Protect Contacts of Superconducting Devices

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No 9, pp 171-180

[Article by A. Yu. Volkov, A. A. Bush, Obninsk Institute of Atomic Energy (manuscript received 13 Jul 94)]

[FBIS Summary] A crucibleless zone melting method with optical heating is used for the first time to obtain textured bars of Bi-2212 phase high-temperature superconducting material with predetermined changes in texturing (by changing the linear rate of crystallization) and in the content of dopant phases along the axes. The texturing method is described in detail. Local inhomogeneities and their effect on the properties of the high-temperature superconducting samples were examined. X-ray analysis of the samples was performed and the local cation chemical compositions were determined. A Hall microsensor was used to measure lo-

cal magnetic fields. The method of monitoring critical parameters in samples with controlled alteration of structure is described. By controlling the texturing and changing the phase composition, samples were formed which have higher values of the critical current density in contact regions. These samples may be used to protect the high-temperature superconductor-metal contacts of high-current superconducting devices from thermal destruction. The local current-carrying ability of these samples was tested. A comparative experiment demonstrated their effectiveness in protecting contacts from thermal destruction by the transport current in an increasing external magnetic field. Figures 3; references 32: 15 Russian, 17 Western.

Russia: Features of the Generation and Development of Recirculation Flow Zones in Shear Layers of Supersonic Streams

964D0225A Novosibirsk PRIKLADNAYA MEKHANIKA I TEKHNIЧЕСКАЯ ФИЗИКА in Russian No 5, Sep-Oct 95 pp 30-39

[Article by G. F. Glotov, Central Aerohydrodynamic Institute, Zhukovskiy; UDC 532.526.5 (manuscript received 10 Dec 93; after revision 14 Nov 94)]

[FBIS Summary] The author's and other researchers' experimental data on supersonic flows are used to develop schemes for the flow and stability loss boundaries of supersonic and subsonic shear layers (eddy pinches, boundary layer) when they interact with shock waves accompanying the generation of zones of recirculation flow or a separation. The generation of a recirculation flow zone (separation) in a shear layer, in contrast to a developed separation, depends on the parameters of the layer (minimum Mach number, etc.) and shock wave intensity. The picture of the transition of a local separation to a large-scale separation is refined. The problem is reduced to the problem of the deformation (destruction) of the shock wave as it interacts with an eddy flow. Two types of eddy flows are examined, a longitudinal eddy pinch in a supersonic flow, and a large-scale regular transverse eddy formed in the boundary layer. Both problems are studied experimentally. In both cases there is a unique sequence of changes in the flow picture. For the first case, it is possible to have separationless rotation of the flow with a supersonic shear layer at angles close to the maximum values. Recirculation

flow zones are formed when the shear layer angle is greater than or equal to the flow rotation angle. Parameters are determined for the formation of a large-scale separation. When a developed separation is being generated there are characteristic changes in the properties of the periodic interaction between the shock wave and large-scale eddy structures which are regularly formed in a turbulent boundary layer. A physical model is developed which explains the nonsteady-state effects at this stage of development. Figures 3; references 18: 13 Russian, 5 Western.

Russia: Resistance Control in Supersonic Gas Streams by Discharging a Stream of Liquid

964D0225B Novosibirsk PRIKLADNAYA MEKHANIKA I TEKHNIЧЕСКАЯ ФИЗИКА in Russian No 5, Sep-Oct 95 pp 40-47

[Article by A. Ye. Berdyugin, V. M. Fomin, V. P. Fomichev, Institute of Theoretical and Applied Mechanics, Siberian Division, Russian Academy of Sciences, Novosibirsk; UDC 532.525.2:533.6.011 (manuscript received 28 Jul 94; after revision 10 Oct 94)]

[FBIS Summary] It has been found that local discharge of a stream of liquid from blunt bodies in the face of a supersonic flow reduces the resistance of blunt bodies. The physical interaction of the liquid and the oncoming gas stream has been described. This paper studies this phenomenon in detail and establishes the optimal discharge modes which achieve maximum reduction in resistance. Discharge of liquid from the head of the model yielded results similar to the case of discharge from a needle. The reduction in aerodynamic resistance was dependent not only on the rate of emission of liquid, but also on the diameter of the stream. For each nozzle diameter there is an optimal flow rate at which resistance is minimal. Increasing the flow rate beyond that level increases resistance. The critical value of the flow rate can be described by the Reynolds number of the stream. There is also a critical limit on nozzle diameter beyond which resistance is not reduced (0.04 times the diameter of the cylindrical part of the model). The effect of nose shape is explored. The liquid stream forms a fictitious liquid body with optimal resistance in a given supersonic flow. Figures 9; references 14: 12 Russian, 2 Western.

Russia: Designing Fiber Composites with Given Deformation-Durability Characteristics

964D0225C Novosibirsk PRIKLADNAYA MEKHANIKA I TEKHNIЧЕСKAYA FIZIKA in Russian No 5, Sep-Oct 95 pp 113-123

[Article by A. G. Kolpakov, Siberian State Academy of Telecommunications, Novosibirsk; UDC 539.3 (manuscript received 6 Sep 94)]

[FBIS Summary] This paper presents a mathematical solution to the problem of designing composites armored with a fibers with a high Young modulus to have given deformation and durability characteristics. The problem is formulated as an incorrect problem and is studied mathematically. A numerical algorithm to solve the problem is proposed. Examples are presented and analyzed. The cases of a composite with average elasticity characteristics, and symmetrical fiber configuration are examined. Design of a composite with maximum durability is considered. Figures 3; table 1; references 22: 16 Russian, 6 Western.

Russia: Numerical Modeling of Transonic Flow Over a Wing Profile in a Wind Tunnel

964D0287A Moscow ZHURNAL VYCHISLITELNOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian Oct 95 No 10, pp 1518-1537

[Article by S. A. Velichko, Yu. V. Lifshits, V. M. Neyland, I. A. Solntsev, A. M. Sorokin, Moscow; UDC 533.6:533.7 (manuscript received 11 Oct 94)]

[FBIS Summary] This paper develops a method to numerically model the transonic flow of a viscous gas over a wing profile in the working region of a wind tunnel. The effect of viscosity is considered only in the boundary layer at the profile and in its wake. In all other areas the flow is considered a potential flow. Solutions in these two regions are compared using the theory of viscous-nonviscous interaction. The boundary conditions at the walls of the tunnel satisfy the Darcy condition for an ideal porous perforation or the conditions which model walls with longitudinal slits, or are given by an empirically obtained distribution of pressures. The conditions at the entrance and exit boundaries of the working region are studied to guarantee the correct statement of the boundary value problems that are obtained. Boundary problems are solved numerically using the WIN-TUN program specially designs for this purpose. The solution is constructed with iterations of the alternating Shvartz method in two partially overlapping regions. The flow problem is solved in a component network (an external Cartesian and internal curvilinear network). The problem of viscous-nonviscous interaction is solved using the AEROFOIL program. The results are compared

with experimental data and asymptotic formulas of the subsonic theory of small perturbations. Figures 12; references 23: 6 Russian, 17 Western.

Russia: Calculation of Flows of Viscous Gas Based on Compact Third-Order Schemes

964D0287B Moscow ZHURNAL VYCHISLITELNOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian Oct 95 No 10, pp 1538-1551

[Article by A. D. Savelyev; UDC 519.6:533.7 (manuscript received 7 Dec 93; after revision 30 Mar 95)]

[FBIS Summary] An algorithm is developed to solve problems involving the flow of viscous gas in curvilinear networks. It is based on an approximation of the Navier-Stokes equations with compact third-order schemes. The initial equations used are a complete non-steady-state system of two-dimensional Navier-Stokes equations written in a conservative form. The systems of coordinates were converted to make the algorithm more efficient when calculating gas flow in regions with curvilinear boundaries and in regions with great compression of coordinate lines. The dependence of viscosity on enthalpy is considered. Turbulent viscosity is determined from a turbulence model. Results are presented of the calculation of an separation of the turbulent boundary layer by a shock wave, flow over an aerodynamic profile, and networks of profiles of turbo-machines by a viscous gas. Figures 8; references 14: 11 Russian, 3 Western.

Russia: Resistive-Wall Instability of External Kink Modes in a Tokamak

964D0194A Moscow FIZIKA PLAZMY in Russian Oct 95 No 10, pp 835-848

[Article by A. B. Mikhaylovskiy, B. N. Kuvshinov, Institute of Fusion, Kurchatov Institute Russian Science Center; UDC 533.951 (manuscript received 23 Mar 95)]

[FBIS Summary] This paper develops an analytical theory of the instability of external kink modes in a tokamak caused by wall resistivity with a consideration of toroidal effects. It is assumed that each mode is a set of several poloidal harmonics; one is the main harmonic, and the remaining harmonics are accompanying (lateral). Some of the accompanying harmonics may have a singular point in the plasma. Local and nonlocal balloon effects are considered in the description of the interaction of each of these harmonics with all the remaining harmonics. In addition, the associated magnetic well (magnetic hill) is considered. A system of approximate (model) equations is derived which makes it possible to study individually nonlocal balloon effects and local effects which are characteristic of the Mercier mode (the

combined effect of a magnetic well and local balloon effects). A general expression is obtained for the increment in the form of a sum of cylindrical and toroidal parts. The cylindrical part of the increment is calculated for the case of parabolic distribution of the longitudinal current. The contribution to the toroidal part of the increment made by the accompanying harmonics without singular points in the plasma, as well as harmonics with singular points, is found. It is shown that in both cases the accompanying harmonics play a destabilizing role and cause the experimentally observed sensitivity of this instability to plasma pressure. A case is examined where the singular point of the main harmonic is close to the plasma boundary. It is shown that in this case the instability may be sensitive to the magnetic well and local balloon effects associated with this harmonic. References 19: 10 Russian, 9 Western.

Russia: Stabilization of an External Kink Mode in a Tokamak with Rotating Plasma

964D0194B Moscow FIZIKA PLAZMY in Russian
Oct 95 No 10, pp 849-864

[Article by A. B. Mikhaylovskiy, B. N. Kuvshinov, Institute of Fusion, Kurchatov Institute Russian Science Center; UDC 533.951 (manuscript received 23 Mar 95)]

[FBIS Summary] This paper develops an analytical theory of the stabilization of external kink modes in a tokamak with a rotating plasma. This stabilization was demonstrated in experiments on the DIII-D tokamak. Toroidal plasma rotation affects the stability of external kink modes due to the presence of accompanying harmonics which have singular points lying within the plasma. It is assumed that along with the main poloidal harmonic, the disturbance contains one or several accompanying poloidal harmonics with a singular point lying within the plasma. The behavior of these harmonics is governed by ideal magnetohydrodynamic effects and inertial effects which depend on the velocity of toroidal plasma rotation. The plasma inertia and associated toroidal effects are considered near this point (the compressed part of the plasma pressure and the longitudinal viscosity). These effects are described kinetically with a consideration of toroidal blocking of resonant ions, which is essential if the velocity of toroidal plasma rotation is small compared with the thermal velocity of the ions. This theory includes both ionic Landau attenuation and attenuation due to toroidal blocking. The effects of large plasma pressure, due to the finite Mercier factor s , are considered near the resonant point. The contribution to inertial effects to the increment of external kink modes is substantially dependent on two factors: the ratio of the angular velocity of plasma rotation to the Alfvén frequency, and the Mercier factor at the singu-

lar point of an accompanying harmonic. Plasma rotation has the greatest effect on external kink modes where $s < 0$, that is, in situations which foster the development of instability in a nonrotating plasma. In this case plasma rotation plays a stabilizing role, even if one ignores ionic Landau attenuation. The analysis also confirms the assumption of Bondeson and Ward on the stabilizing role of ionic Landau attenuation if this attenuation is not too small. References 17: 9 Russian, 8 Western.

Russia: Observation of LF Plasma Turbulence in LH Heating Experiments at the FT-2 Tokamak

964D0194C Moscow FIZIKA PLAZMY in Russian
Oct 95 No 10, pp 865-871

[Article by V. N. Budnikov, V. V. Dyachenko, L. A. Yesipov, Ye. R. Its, S. I. Lashkul, O. Perematko, A. Yu. Stepanov, V. Yu. Shorikov, Ioffe Physicotechnical Institute; UDC 533.9.082.74 (manuscript received 29 Nov 94; after revision 29 Mar 95)]

[FBIS Summary] Amplified scattering of microwaves and reflectometry were used in FT-2 tokamak experiments to reveal some features of the behavior of plasma microturbulence at 0-500 kHz in three modes: in ohmic mode, in LH heating, and in ohmic improved confinement after a high-frequency pulse is shut off. Two types of vibrations were observed in amplified scattering and reflectometry: vibrations in the magnetohydrodynamic range (< 100 kHz) and drift vibrations (100-500 kHz). In both ohmic modes one observes a noticeable maximum of the scattered signal at the plasma periphery. In LH heating there is a substantial (up to 50 percent) suppression of peripheral plasma vibrations. In the amplified scattering signal one observes a suppression of frequencies > 100 kHz. The reflectometric signal exhibits suppression of all recorded frequencies. In the improved confinement mode, a decrease in the amplitude of vibrations is recorded only with reflectometry. Figures 9; references 13: 6 Russian, 7 Western.

Russia: Nonlinear Evolution of Ultrastrong Laser Pulses in a Plasma. New Effects of Magnetic Interaction Between Strong Beams of Electromagnetic Radiation

964D0194D Moscow FIZIKA PLAZMY in Russian
Oct 95 No 10, pp 884-896

[Article by G. A. Askaryan, S. V. Bulanov, F. Pegoraro, A. M. Pukhov, Institute of General Physics, Russian Academy of Sciences, Department of Theoretical Physics, University of Torino, Italy, Moscow Physi-

cotechnical Institute; UDC 535.21;538.61 (manuscript received 17 Nov 94))

[FBIS Summary] This paper presents results of numerical modeling and analytical description of two-dimensional modes of propagation of short relativistically strong laser pulses in plasma of subcritical density. The relativistic self-focusing and filamentation of the laser pulse are demonstrated. Relativistic self-focusing in the plasma leads to self-channeling of radiation with a substantial increase in the intensity of electromagnetic radiation. Plasma turbulence develops within the channel and is accompanied by the appearance of fast particles. No regular electric field structure is observed due to the spontaneous development of instability. The effect of asymmetrical distribution of radiation within the pulse is studied. When filamentation occurs, the laser pulse splits into several channels which coalesce over time. External magnetic fields bend the channels, and they fuse due to the mutual attraction of electric currents carried by the fast particles in the channels. It is shown that it is possible to collect energy from several channels into one. Pulses shorter than the plasma wave, but larger in cross section than the length of the plasma wave, generate in the plasma a regular wake whose electric field accelerates charged particles. The structure of the plasma wake is such that electromagnetic radiation is focused in it. Figures 7; references 46: 17 Russian, 29 Western.

Russia: Modeling the Deposition of Diamond Films in a DC Discharge Reactor

964D0194E Moscow *FIZIKA PLAZMY* in Russian
Oct 95 No 10, pp 921-927

[Article by Yu. A. Manelevich, A. T. Rakhimov, N. V. Suetin, Scientific Research Institute of Nuclear Physics, Lomonosov Moscow State University, Digazkron joint stock company; UDC 533.9 (manuscript received 25 Jan 95)]

[FBIS Summary] Two-dimensional self-consistent models are developed for reactors which deposit diamond films from the gas phase with activation of the mixture by a DC current. The models are turned into software for a personal computer. Other models of diamond film deposition reactors are described. The equations of conservation of mass, momenta, energy, and components of the mixture are solved numerically in cylindrical geometry. The distributions of the electric field and density of electrons are determined from the condition of conservation of total current and the electron balance equation. To find the electron critical coefficients the Boltzmann equation is solved for an electron energy distribution function. A comparison of theoretical and experimental results is presented. The models developed here can be

used to model reactor processes in two dimensions, define parameters and processes affecting the rate of film deposition, and study the dependence of results on various parameters (pressure, gas composition, power consumption, and reactor configuration). Figures 4; table 1; references 19: 4 Russian, 15 Western.

Russia: Competition of Antiferromagnetism and Superconductivity in $R\text{Ba}_2\text{Cu}_3\text{O}_{6+x}$ ($R = \text{Lu}, \text{Tm}$)

964D0220A Moscow *PISMA V ZHURNAL
EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI*
in Russian Vol 62 No 7-8, 10 Oct 95 pp 562-566

[Article by A. N. Lavrov, L. P. Kozeyeva, Institute of Inorganic Chemistry, Siberian Division, Russian Academy of Sciences, Novosibirsk (manuscript received 24 Aug 95)]

[FBIS Summary] This is a precise study of the anisotropic conductivity of $R\text{Ba}_2\text{Cu}_3\text{O}_{6+x}$ ($R = \text{Lu}, \text{Tm}$) monocrystals in the oxygen content region near the antiferromagnet-superconductor phase boundary when there is a smooth increase in the concentration of current carriers. Charge carriers do not appear in the CuO_2 plane until the oxygen content reaches $x \sim 0.4$. A further increase in x leads to a drastic increase in the concentration of charge carriers. One should also expect a drastic change in conductivity and the Hall coefficient as x increases above this threshold, but this is not observed. Superconductivity arises only at a rather high charge carrier concentration. There must be a mechanism at lower x which suppresses superconductivity. It is found that there is an increase in interplanar resistance due to partial dielectrization of the system. The superconducting state competes with three-dimensional magnetic ordering. Suppression of far antiferromagnetic order immediately leads to the appearance of superconductivity. The competition between antiferromagnetism and superconductivity determines the superconductivity threshold. Figures 3; references 10: Western.

Russia: Compressibility of Iron, Aluminum, Molybdenum, Titanium, and Tantalum at Shock Wave Pressures of 1-2.5 TPa

964D0219A Moscow *PISMA V ZHURNAL
EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI*
in Russian Vol 62 No 7-8, 10 Oct 95 pp 572-575

[Article by R. F. Trunin, N. V. Panov, A. B. Medvedev, All-Russian Scientific Research Institute of Experimental Physics, Sarov, Nizhegorod Oblast (manuscript received 4 Sep 95); first paragraph is abstract]

[FBIS Translated Text] *The compressibility of five metals at pressures of 1.0 TPa (aluminum) to 2.5 TPa (tan-*

talum) is studied under laboratory conditions. The pressure was created by the impact of a hemispheric steel casing accelerated by the explosion products of a converging detonation wave with a velocity of up to 23 km/s. The experimental data are compared with results obtained using the strong shock waves of underground nuclear explosions.

The underground nuclear test ban has made it impossible to measure the compressibility of substances using strong shock waves with amplitudes greater than 1-2 TPa. Existing explosive-type laboratory equipment¹ is limited to pressures $P \leq 1$ TPa (for substances with an initial density $\rho = 8.0$ g/cm³). Even if one does not consider the general interest in furthering measurements at very high pressures, after the introduction of the moratorium on underground blasts, several issues have remained unclear which require studies at terapascal pressures. These include, for example, contradictions in the data on the compressibility of molybdenum (at $P = 2$ TPa), the necessity of direct comparison of laboratory and "underground" data for aluminum at $P = 1$ TPa, and several other issues. To resolve these issues in laboratory conditions it was necessary to have equipment which measures compressibility at these pressures. This type of equipment has been created; see Ref. 2 which publishes the results of measurements of compressibility of tantalum at $P = 1.7$ TPa. The measurements were taken under conditions where the high pressures were created by the impact of a steel casing accelerated by the explosion products of a converging detonation wave along the measurement core with metal samples located near the center of the system.

The pressures obtained in Ref. 2 are record values for laboratory conditions. However, they still do not enable us to resolve the issue of direct comparison of data on aluminum and molybdenum, which requires the creation of equipment with pressures of 2 TPa. To realize these conditions, it was decided to use the device from Ref. 2 in a forced operating mode. To do this, the measurement core with metal samples was brought closer to the center of the system to the minimum radius where it was still possible to measure wave velocities with the necessary recording accuracy. We note that we are talking about measurement of the absolute, in a methodological sense, compressibility of substances, that is, when the thermodynamic values which characterize the state of the substance are such that, for example, pressure and density of impact compression are determined directly

from experimentally determined kinematic parameters, wave and mass velocity.

The experiments, as is typical in these cases, recorded the velocity of the shock wave created in the studied metal samples by the impact of a steel casing accelerated by the explosion products of a converging detonation wave with a velocity of up to $W = 23$ km/s. The samples were hemispheric tablets, segments 9 mm in diameter and 3.5 mm thick covered above by a steel hemispheric screen of the same thickness. An electric contact recording system was used with recording of the time of passage of the shock wave in the samples. Recording was done with SUPI-type recorders with an error of miscalculating the oscillograms of no worse than 5×10^{-6} s.

In this device, when the casing approaches the screen, in addition to the main strong shock wave, a relatively weak shock wave arises (formed by the compressed air "cushion" in front of the moving casing) which precedes the main wave front. To prevent premature closure of the upper level contacts by this advance wave, an air gap 0.3 mm thick was introduced between them and the screen. This "extinguishes" the first wave without having a noticeable effect on the main front.

In each experiment, three samples of different metals were put in place: in most cases iron was among them. The average value of the wave velocities obtained in the experiments, considering small (less than 1 percent) corrections for different attenuation of waves in the metals compared with iron, were as follows: iron, standard metal, $D = 20.19 \pm 0.25$ km/s; aluminum $D = 24.17 \pm 0.40$ km/s; tantalum, $D = 15.85 \pm 0.20$ km/s; titanium, $D = 20.95 \pm 0.40$ km/s; molybdenum, $D = 18.74 \pm 0.40$ km/s.

The subsequent procedure for processing the results was as follows: the initial states in iron were determined from the experimental wave velocity in iron and the known $D-U$ function (U is the mass velocity of the motion of the substance beyond the shock wave front): $D = 5.68 \pm 1.257U$ (initial density of iron $\rho_0 = 7.85$ g/cm³) which holds true at 13 km/s $< U < 25$ km/s. The initial states for iron were $U = 11.54$ km/s, $P = 1.83$ TPa. Afterwards, the wave velocities in the studied metals were used to construct a $P-U$ diagram and determine the compression parameters. In this case the results are as follows:

АЛЮМИНИЙ (1)

$$U = 15.08 \text{ км/с}, \quad P = 0.99 \text{ ТПа}, \quad \rho = 2.71 \text{ г/см}^3 \quad (\rho_0 = 2.71 \text{ г/см}^3);$$

ТАНТАЛ (2)

$$U = 9.36 \text{ км/с}, \quad P = 2.47 \text{ ТПа}, \quad \rho = 40.00 \text{ г/см}^3 \quad (\rho_0 = 16.38 \text{ г/см}^3);$$

ТИТАН (3)

$$U = 13.67 \text{ км/с}, \quad P = 1.29 \text{ ТПа}, \quad \rho = 12.95 \text{ г/см}^3 \quad (\rho_0 = 4.5 \text{ г/см}^3);$$

МОЛИБДЕН (4)

$$U = 10.74 \text{ км/с}, \quad P = 2.05 \text{ ТПа}, \quad \rho = 17.80 \text{ г/см}^3 \quad (\rho_0 = 10.2 \text{ г/см}^3).$$

Key: (1) Aluminum; (2) Tantalum; (3) Titanium; (4) Molybdenum

In the figure they are compared with available results^{1,2,14} obtained in laboratory conditions and in underground nuclear blasts.

What conclusions can we draw from these data?

Aluminum. The new experimental point virtually coincides with the measurements from Ref. 6 obtained in underground blasts. It may be assumed, therefore, that both results are mutually consistent. This removes the question of the correctness of assumptions made in Ref. 6 regarding the mass velocity in aluminum and that the reference tablets mounted in the studied unit were moving with identical velocities.

Titanium. The new measurements confirmed the previously accepted¹³ pattern of D_p (screen)- D_n . This had to be done because in this relationship, which is two intersecting straight lines with different slopes, the point of intersection and the slope of the second section were determined by analogy with dependences for other pairs

of metals, and required direct experimental confirmation. The data obtained in this paper are for the region of states characteristic of the second section of the D - D diagram, and indicate the correctness of the interpretation of results in Ref. 15.

Molybdenum. The data of underground tests^{3,15} differ greatly from one another: relative to the linear D - U dependence which extends from the laboratory states to the region of states characteristic of underground blasts, the results of Ref. 3 are below (see figure) and the measurements of Refs. 4 and 9 are above this line. The data from Ref. 5 occupy an intermediate position between these two groups, but unfortunately, the parameters obtained there do not greatly exceed the laboratory range of measurements. The new point located at pressures close to those in Refs. 3, 4, and 10 confirms the linear nature of D - U for molybdenum from Refs. 11 and 5, and indicates that the results from Refs. 3, 4, and 9 are erroneous.

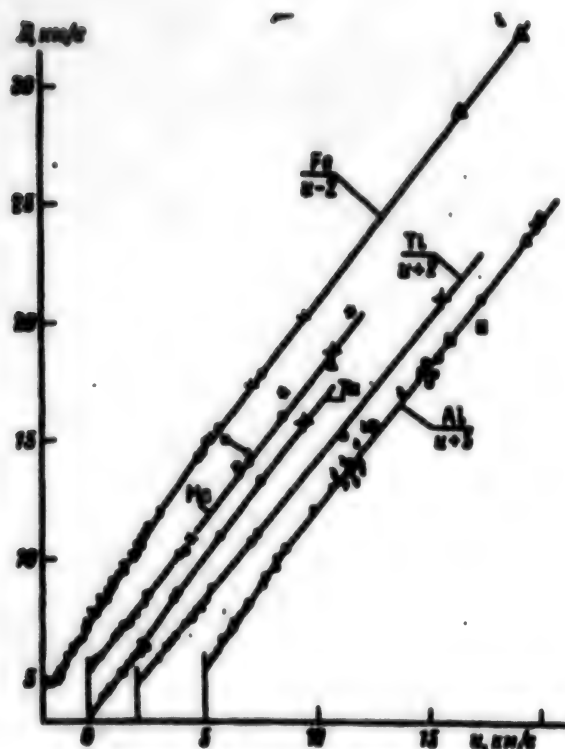


Figure. Impact adiabats of iron, molybdenum, tantalum, titanium, and aluminum.

Key: Laboratory measurements: cross, open circle, initial states in iron and corresponding data for metals (this paper); open circle, inverted triangle, closed circle, dot, dot, results from Refs. 2, 13, 1(12), 14, 15, respectively; measurements from underground nuclear blasts: inverted triangle, star, triangle, barred circle, triangle, open square, crossed circle, data from Refs. 10, 9, 3, 4, 6, 7, 8, respectively. X-axis, u , km/s; Y-axis, D , km/s.

Tantalum. The goal of the measurements was to study its compressibility at higher pressures than had been achieved in Ref. 11. The pressure of 2.4 TPa obtained here is a record value for laboratory measurements.

This, under the conditions of a laboratory experiment, data have been obtained on the absolute compressibility of tantalum, molybdenum, titanium, and aluminum at pressures which are more than a factor of two higher than known laboratory values for these metals. The measurements have made it possible to refine the

position of the impact adiabats of these metals in the region of very high pressures and to resolve the remaining issues in the interpretation of data obtained for aluminum, molybdenum, and titanium under the conditions of underground nuclear blasts.

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Russia: Quasi-Threshold Character of Absorption of Far IR Light in GaSb/InAs/GaSb Quantum Wells
964D0223A Moscow PISMA V ZHURNAL
EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI
in Russian Vol 62 No 7-8, 25 Oct 95 pp 611-615

[Article by A. D. Dmitriyev, S. A. Yemelyanov, S. V. Ivanov, Ya. V. Terentyev, Ioffe Physicotechnical Institute, Russian Academy of Sciences, St. Petersburg (manuscript received 13 Sep 95)]

[FBIS Summary] A distinguishing feature of quantum wells based on type II heterojunctions, in particular, GaSb/InAs/GaSb, is that some of the permitted electron states in the well lie in the background of the continuous spectrum of the valent zone of GaSb. There are two important consequences: the electron gas in the well is greatly degenerated and the electron spectrum has a region of quasi-three-dimensional states. The latter is linked with the quasi-threshold absorption of far infrared radiation and its strong temperature dependence. The experiments here used structures with a single quantum well 200 Angstroms wide. The effect of surface potential was eliminated. The quasi-three-dimensional states have wave functions which oscillate beyond the quantum well. It is found that wells more than 160 Angstroms wide have two levels of dimensional quantization. The lower one, like the surface state level, is completely below the Fermi level. Electrons at this level do not participate in conductivity or absorption. The zone of quasi-three-dimensional states is also completely filled with electrons at low temperatures. The second level is only partially filled. The electron gas in it is greatly degenerated and it is this level that is responsible for the semimetallic properties of the quantum well of GaSb/InAs/GaSb. The proposed model is confirmed by the strong temperature dependence of absorption. Figures 3; references 3: 2 Russian, 1 Western.

Russia: A Study of the Relationship Between Structure and Effect in a Series of Aminostigmine Derivatives

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[Article by V.B. Prozorovskiy, L.V. Pavlova, L.V. Belozeroval, I.M. Suslova, A.V. Kokushkina, and V.K. Mukhomorov, Military Medicine Scientific Research Institute, Russian Federation Ministry of Defense, St. Petersburg; manuscript received 12 Jul 94; UDC 547.495.1:547.823+615.217.34]

[FBIS Summary] Ten new aminostigmine derivatives (esters of dimethylcarbamic acid and 2-aminomethyl-3-oxypyridine) with substituents at the nitrogen atom in the second position of the pyridine ring were synthesized. The compounds were synthesized by an original method that entailed mixing dimethylcarbamoyl chloride with sodium salts of 2-substituted 3-oxypyridines in a moisture-free medium of dry benzene at room temperature for several hours. The corresponding 3-oxypyridines were synthesized by the Mannich reaction. The structure and purity of the pyridylcarbamates were demonstrated by elemental analysis, spectrometry, and chromatography. In ultraviolet light, the aminostigmine derivatives had clear absorption peaks at 265 +/- 2 nm (maximum) and 240 +/- 2 nm (minimum). In their infrared spectra, absorption bands were evident in the interval from 1,750 to 1,730 cm⁻¹, which is indicative of the presence of a carbamoyl group. The aminostigmine derivatives' ionization constants were determined by potentiometric titration with a glass electrode. Their ionization constants pK_a¹ and pK_a² ranged from 4.39 to 4.79 and 8.36 to 9.43, respectively. The hydrophobicity of the newly synthesized compounds was expressed through the coefficient of their distribution in the system octanol-buffer solution (pH 7.4); the said coefficients ranged from 1.1 to 11.0. The new compounds' carbamate concentration was measured by spectrophotometry at a wavelength of 265 +/- 2 nm, and their toxicity, as estimated on the basis of their median lethal dose [LD₅₀] in accordance with Prozorovskiy's table method, was found to vary significantly (LD₅₀ = 0.23 to 200.0 mg/kg). The new aminostigmine derivatives' anticholinesterase activity was estimated by using the kinetic constants of their reaction with cholinesterase in in vitro experiments. Of the 10 aminostigmine derivatives synthesized, those with the following empirical formulas were deemed most interesting: C₁₇H₂₇N₃O₆; C₁₈H₂₉N₃O₆; C₁₉H₃₁N₃O₆ and C₂₀H₃₃N₃O₆. Their affinity constants ranged from 4.6 x 10⁻⁷ to 0.05 x 10⁻⁷ m. Regression analysis was used in an attempt to establish a link between selected physicochemical parameters of

the new pyridylcarbamates and their properties. The kinetic constants of the new aminostigmine derivatives' reaction with cholinesterase were shown to be a function of their hydrophobicity and the linear size parameters of their radicals. The new compounds' anticholinesterase activity and toxicity were indeed affected by various physicochemical parameters (their hydrophobicity [π] and two of the steric indices of their substituents [L and B₁]). The experiments thus confirmed the possibility of synthesizing cholinesterase inhibitors that have an anticholinesterase activity superior to that of aminostigmine but a much lower toxicity. Tables 2; references 27: 8 Russian, 19 Western.

Ukraine: Synthesis and Properties of Self-Binding Microflake Graphite

964D0275A St. Petersburg ZHURNAL PRIKLADNOY KHIMII in Russian Jan 95 Vol 68 No 1, pp 54-57

[Article by A.V. Melezhik, R.B. Rudy, L.V. Makarova, and A.A. Chuyko, Surface Chemistry Institute, Ukrainian National Academy of Sciences, Kiev; manuscript received 10 Jan 94; UDC 546.26:541.182.024]

[FBIS Summary] A previous publication reported the development of strong, flexible graphite films that are formed by drying aqueous suspensions of microflake graphite consisting of graphite flaks with a thickness on the order of 0.01-0.2 μm and a diameter on the order of 10-50 μm and containing a surface layer of graphite oxide that acts as a binder. The present communication reports a study of the self-binding polymer graphite that was conducted to determine the dependence of the properties of the microflake graphite and films formed from it on the conditions under which the graphite is synthesized and the methods used to form the films. The studies were performed with type GSM-1 natural graphite (produced by the Zavalevskiy Combine and containing impurities in a concentration of no more than 0.1 percent) and with concentrated chemically pure sulfuric acid containing 95 +/- 0.2 percent H₂SO₄. The study samples of microflake graphite were synthesized in a 300-ml vessel by mixing 5 g of graphite and 150 ml of a sulfuric acid solution containing various quantities of peroxo compounds, covering the container with polyethylene film to protect the contents against the moisture in air, and placing it in a drying cabinet (T = 60-80°C) to complete the expansion reaction. During the course of the reaction, the mixture thickened, and the graphite crystals (diameter, 0.2 to 0.5 mm) were transformed into flakelike particles with the said lateral dimension and lengths up to 1 cm. After the mixture had been cooled to room temperature, it was dispersed by a mixer with a rotating blade. The resultant mother of pearl-dark blue suspension of microflakes of intercalated graphite com-

pound was filtered through a porous glass filter (40 μm), after which the sediment was covered with 200 ml of cold water and again processed in the mixer to break up the clumps. The resultant suspension of microflake graphite was rinsed with water on a paper filter for several days (without a vacuum) until a neutral filtrate reaction was achieved. A microflake graphite suspension containing 2 percent dry matter was used in the subsequent experiments. It was discovered that as the concentration of peroxide compounds in the initial solution is increased, the apparent volume of the expanded reaction mixture initially increases and then reaches a peak value of 200 cm^3 per gram of starting graphite. At the same time, the average thickness of the microflakes, which is inversely proportional to the coefficient of the microflake graphite's absorbance in an aqueous suspension, decreases monotonically. The concentration of sulfur in the said study samples ranged from 1.0 to 1.5 percent by weight. The bonds between the graphite flakes that are responsible for the strength of microflake graphite films were found to form during the drying and heat treatment processes; subsequent compaction did not affect the films' specific strength. The most effective splitting of the graphite crystals into microflakes was achieved when the crystals were subjected to intercalation by a solution of permonosulfuric acid in sulfuric acid with a minimum amount of free water in the system. Tables 2; references 11: 8 Russian, 3 Western.

Ukraine: Microflake Graphite-Based Electrode Materials

964D0275B St. Petersburg ZHURNAL PRIKLADNOY KHMII in Russian Jan 95 Vol 68 No 1, pp 58-61

[Article by A.V. Melezhiik, K.E. Gulyanitskiy, I.V. Monakhova, R.B. Rudyi, K.N. Khomenko, and A.A. Chuyko, Surface Chemistry Institute, Ukrainian National Academy of Sciences; manuscript received 10 Jan 94; UDC 546.26:541.182.024+541.135:537.224]

[FBIS Summary] A study examined the electrophysical properties of microflake graphite-based composite materials with a well-developed surface and with a graphite oxide phase on the microflakes' surface. The composites were synthesized from milled type SKN activated charcoal and microflake graphite that had been produced as described elsewhere in the form of an aqueous suspension with a concentration of 40 g/l. The microflake graphite's absorbance in an aqueous suspension, which is inversely proportional to the microflakes' thickness, equaled 11 lumens/g/cm. The microflakes' diameters ranged from 10 to 50 μm , and their thicknesses ranged from 0.01 to 0.1 μm . The study samples were prepared as follows: activated charcoal powder was mixed with the suspension of microflake graphite.

The mixture was poured onto a ceramic substrate and air-dried at room temperature for 1-2 days. Each thin flexible sheet of study material produced was divided into two parts, one of which was compacted under a pressure of 5 MPa. The samples were then heated to 300°C and held at that temperature for 3 hours to permit carbonization of the graphite oxide groups. A graphite oxide suspension in the form of an aqueous suspension containing the air-dried material in a concentration of 0.9 percent was used in experiments examining the effect of the graphite oxide phase on the study systems' electrical conductivity. Samples based on activated charcoal with polyvinyl alcohol as a binder were used for comparative studies of the new materials' electrophysical properties. Two types of silica were used to study the effect of nonconductive powder additives on the electrical conduction of the films made of the microflake graphite with a graphite oxide phase on its surface: A-300 aerosil and quartz powder. Polymer and powder components were also added to the study microflake graphite by mixing aqueous solutions or suspensions with the microflake graphite and then drying the mixtures. As expected, as the amount of activated charcoal added to the microflake graphite was increased, its resistivity also increased. Compaction had virtually no effect on the material's mass resistivity, although the apparent density of the compacted samples nearly doubled after compaction. The electric resistance of the material consisting of 50-percent activated charcoal and 50-percent microflake graphite with a graphite oxide phase on its surface was nearly two orders of magnitude less than that of compressed pure activated charcoal powder and only one-thirtieth that of samples of activated carbon fiber material with a specific surface similar to that of the study composite. The experiments confirmed that microflake graphite may be used as a binder and electricity-conducting component in the creation of electrode materials whose electrochemically active component possesses poor electrical conductivity. The nature of the concentration dependence of the electrical conductivity in systems consisting of the microflake graphite with a graphite oxide phase on its surface and a non-electricity-conducting component was found to depend on the ratio of the components' particle sizes. Although the electrical conductivity of the composites consisting of activated charcoal and microflake graphite with a graphite oxide phase on its surface was significantly greater than that of the carbon fiber material, the internal resistance of an actual electrode made of the new composite would be somewhat higher on account of slowed diffusion of ions (lesser accessibility of the pores). Figure 1, table 1; references 8: 6 Russian, 2 Western.

Ukraine: Electrical Conductivity of Microflake Graphite-Filled Composites

964D0275C St. Petersburg ZHURNAL PRIKLADNOY KHIMII in Russian Jan 95 Vol 68 No 1, pp 62-66

[Article by A.V. Melezhnik and I.V. Monakhova, Surface Chemistry Institute, Ukrainian National Academy of Sciences, Kiev; manuscript received 27 Dec 93; UDC 546.26-162:537.311.3]

[FBIS Summary] The electrical conductivity of a new material consisting of a mixture of microflake graphite and organic and inorganic binders was examined. Two types of microflake graphite were used as the conductive filler: microflake graphite not containing a graphite oxide phase on its surface and microflake graphite containing a graphite oxide phase on its surface. The former was produced by deintercalation of a peroxosulfate graphite compound in the presence of ammonia and subsequent dispersion in a centrifugal field and rinsing off of the formed ammonium sulfate with water. The resultant product was used in the form of a butylacetate suspension with a concentration of dry matter of 10 g/l. The absorbance of the microflake graphite not containing a graphite oxide phase on its surface (which characterizes its dispersion) equaled approximately 13 l/g/cm. The second type of filler, i.e., the microflake graphite containing a graphite oxide phase on its surface, was produced in the form of an aqueous suspension with a concentration of 20 g/l. Its absorbance in an aqueous suspension equaled 11 l/g/cm. A four-electrode circuit was used to measure the surface resistance of study samples of both materials in the form of coatings or thin wafers. AK-156 acrylic lacquer, an aqueous solution of soluble glass, silicate dye based on soluble glass and zinc oxide, type 400 Portland cement, and polyvinyl alcohol were used in experiments examining the effect of the nature of the binder on the microflake graphite's performance. A graphite oxide preparation obtained by processing the microflake graphite with a solution of potassium permanganate in sulfuric acid was used in experiments to determine the effect of the graphite oxide phase. When applied to a substrate in the form of a suspension in an organic solvent, the pure microflake graphite with no graphite oxide phase on its surface formed a porous coating with a resistivity of 0.0043 ohm/g/cm² and an apparent density of 0.1 g/cm³. It was concluded that the best conductive coatings of microflake graphite with no graphite oxide phase on its surface are those in which microflake graphite is present in concentrations of 2 to 9 percent by weight. When microflake graphite is present in concentrations of less than 2 percent by weight, the coatings' resistivity increases sharply. Only a slight decrease in resistance occurs when microflake graphite is present in concentrations greater than 9 percent by

weight. This in turn leads to the appearance of pores in the coating and a worsening of its mechanical properties. When the microflake graphite containing a graphite oxide phase on its surface is applied to a glass substrate without a binder, a coating is formed that has an apparent density of 1.0 to 1.5 g/cm³ and a resistivity of 0.001 ohm/g/cm², which is near the reference data for the mass resistivity of crystalline graphite (0.001 ohm/g/cm²). In the case of silicate composites containing a small amount of microflake graphite with a graphite oxide phase on its surface, mass resistivity was found to be dictated primarily by the presence of graphite oxide phase on the surface of the microflake graphite particles that break down at a temperature of 100-200°C and form a carbonlike structure, thereby increasing the composite's conductivity. As expected, the experiments involving the different binders established that increasing the amount of graphite oxide in the composite results in composites with a higher electric resistance. Given one and the same concentration of microflake graphite with a graphite oxide phase, the mass resistivity of composites consisting of the microflake graphite and soluble glass is much lower than that of composites consisting of microflake graphite and polyvinyl alcohol. Figures 4, table 1; references 10: 7 Russian, 3 Western.

Ukraine: Direct Thermal Oxidative Conversion of Graphite Into Foam Graphite—The Road to New Technologies

964D0275D St. Petersburg ZHURNAL PRIKLADNOY KHIMII in Russian Jan 95 Vol 68 No 1, pp 67-70

[Article by A.P. Yaroshenko and M.V. Savoskin, Physical and Organic Chemistry and Coal Chemistry Institute imeni L.M. Litvinenko, Ukrainian National Academy of Sciences, Donetsk; manuscript received 8 Sep 94; UDC 541.48:546.26]

[FBIS Summary] A new process for direct thermal oxidative conversion of graphite into foam graphite has been proposed that includes heating mixtures of graphite and one of several foaming agents, namely, perchloric acid, magnesium perchlorate, and magnesium and zinc nitrates. Experiments have established that heating mixtures of graphite in which the aforesaid foaming agents are present in concentrations of 50 to 70 percent results in the formation of foam graphite in a single stage. In the case where perchloric acid is used as the foaming agent, white smoke begins to form 5 to 10 seconds after heating of the mixture is begun. After 50-60 seconds, explosionlike swelling of the mixture occurs and foam graphite forms. When salts are used, the process develops in much the same way, the only difference being that a suspension of graphite in a salt melt forms initially, and the mixture

swells approximately 2 minutes after the heating is begun. In experiments where HClO_4 (70 percent) was used as the foaming agent and constituted 10 to 60 percent of the foaming agent-graphite mixture and direct thermal oxidative conversion of graphite was implemented at process temperatures of 200 to 1,000°C, foam graphite with a bulk density of 0.1-0.001 g/cm³ and specific surface of 7-80 cm²/g was formed in a 70-90 percent yield. In experiments where $\text{Mg}(\text{ClO}_4)_2 \cdot n\text{H}_2\text{O}$ was used as the foaming agent and constituted 25 to 90 percent of the foaming agent-graphite mixture and direct thermal oxidative conversion of graphite was implemented at process temperatures of 400 to 1,000°C, foam graphite with a bulk density of 0.1-0.001 g/cm³ and specific surface of 7-60 cm²/g was formed in a 70-95 percent yield. Experiments in which $\text{Mg}(\text{NO}_3)_2 \cdot n\text{H}_2\text{O}$ and $\text{Zn}(\text{NO}_3)_2 \cdot n\text{H}_2\text{O}$ served as foaming agents, foam graphite was produced with bulk densities ranging from 0.2 to 0.09 and 0.2 to 0.02 g/cm³, respectively. The proposed process was demonstrated to be a significant simplification of the conventional two-stage conversion process inasmuch as it combines the formation and swelling of intercalation compounds in a single process stage and eliminates the need to separate the graphite intercalation compounds as intermediate products. Table 1; references 17: 6 Russian, 11 Western.

Russia: Group and Individual Chromatographic Identification of Organic Compounds in Multisection Columns

964D0272A Moscow *KHIMIYA I KHIMICHESKAYA TEKHOLOGIYA* in Russian
Vol 38 No 1-2, Jan-Feb 95 pp 102-106

[Article by M.S. Vigdergauz (deceased), Ye.V. Revinskaya, A.L. Lobachev, I.V. Lobacheva, and Ye.V. Zhugina, Samara State University; manuscript received 2 Jul 93; UDC 543.544]

[FBIS Summary] A new version of the technique of chromatographic identification of the components of mixtures of organic compounds has been proposed that entails determining the values of the said components' chromatographic retention in a multisection composite column with commuted sections filled with sorbents having different polarities. The new technique, which is based on obtaining the retention spectra of an individual substance, permits simultaneous group and individual identification. A previously described group identification algorithm that entails comparing the set of experimentally obtained retention-index differences with the standard spectra of 39 groups of organic compounds stored in a computer data bank is used during the identification procedure. The composite column consists of five sections filled with sorbates having different po-

larities. The stationary phases were selected in accordance with recommendations published by Goldbert and Vigdergauz in 1990. Apiezon L, trifluoropropylmethylsiloxane oil (QF-1), pentaphenyl ether (5F4E), polyethylene glycol with a molecular weight of 20 M (PEG 20M), and 1,2,3-tris(β -cyanoethoxy)propane were applied to N-AW chromaton (10-15 percent) on a solid substrate. The experiment was performed on a Chrom-5 chromatograph with a flame-ionization detector at 120°C. Each section of the composite column was 2 m long and 2 mm in diameter. Nitrogen served as the carrier gas. Spectrochromatograms of 54 organic compounds belonging to different classes were obtained. The differentiation capability of the stationary phases used was shown to be extremely high and to therefore permit group identification with an adequate degree of reliability. The use of dependences of ρ_i on the number of carbon atoms for each group of sorbates permitted simultaneous individual identification as well. The values of ρ_i obtained by using the composite column were found to virtually coincide with the values F_i calculated on the basis of the spec. t_R retained volume values contained in McReynolds' 1966 *Gas Chromatographic Retention Data*. It was therefore concluded that the proposed chromatographic identification technique may be used successfully with published data for individual/group identification of unknown compounds. Figures 4, tables 2; references 9: 6 Russian, 3 Western.

Estonia: Electrochemical Studies of Oxygen, Hydrogen Peroxide, and Superoxide Anion on Thin Metal Films for the Development of Amperometric Sensors

964D0236A Tallinn *PROCEEDINGS OF THE ESTONIAN ACADEMY OF SCIENCES. CHEMISTRY* in English Vol 44 No 2-3, Feb-Mar 95 pp 156-164

[Article by Kaido Tammeveski and Toomas Tenno, Institute of Physical Chemistry, University of Tartu; manuscript received 16 Mar 95; accepted 4 Apr 95]

[FBIS Summary] The electrochemical behavior of oxygen, hydrogen peroxide, and superoxide anion (O_2^-) were examined from the standpoint of their use in developing amperometric sensors. The electrochemical experiments were performed on an SVA-1 voltammetric system by the rotating disk electrode [RDE] technique and cyclic voltammetry. The rotation rate was varied from 360 to 4,600 rpm. The glassy carbon electrodes with a diameter of 0.41 cm were cut from rods and mounted in a Teflon holder. The disk electrodes were polished with 1.0- and 0.3-mm BDH alumina and then subjected to ultrasound treatment in twice-distilled water. The thin metal films were produced by vacuum deposition at 2×10^{-6} torr. A tungsten spiral was used

to form the films. A JEOL JSM-35 CF scanning electron microscope was used to study the films' morphology. The electrochemistry of immobilized cytochrome was studied in 10 mM phosphate buffer (pH 7) containing 10 mM KCl. The immobilization procedure entailed soaking the thin-film gold electrode in 10 mM N-acetyl cysteine for 10 minutes, rinsing it thoroughly with twice-distilled water, immersing it in 10 percent 1-ethyl-3-(3-dimethylaminopropyl)carbodiimide for 20 minutes, rinsing it several times, and then incubating it in 2 mM of a cytochrome *c* solution for 8 hours at 4°C. The superoxide anion was generated by using a xanthine/xanthine oxidase system. All measurements were taken at room temperature (23 ± 1°C). The kinetic parameters of oxygen reduction at the thin-film gold and platinum electrodes provided to be similar to those at the corresponding bulk electrodes. Two distinct linear Tafel slope regions for oxygen reduction were obtained for both the thin-film and bulk platinum electrodes in alkaline electrolyte. The intersection point of the Tafel lines nearly coincided with the onset potential of platinum surface oxidation. The voltammetry curves for oxygen reduction at thin-film gold and platinum electrodes in 1.0 M KCl was plotted and analyzed: In the case of the platinum film, a single wave was observed that had a well-defined diffusion-limited current plateau in the potential range from -0.3 to 0.8 V. As the electrode rotation rate increased, the width of the limiting current region narrowed, and the plateau was not ideally flat. Analysis of the RDE data by the Koutecky-Levich method established that the number of transferred electrons per oxygen molecule was close to four at the potentials of the limiting current region for both electrodes. The gold film showed two oxygen reduction waves on the polarization (*i*, *E*) curves. The region of limited diffusion currents was shifted toward more negative potentials (-0.7 V > *E* > -1.2 V) than in the case of the thin platinum film. The gold films' electrochemical behavior toward oxygen was found to depend on preconditioning of the electrode. Further experiments established the feasibility of using thin platinum films for electrochemical detection of hydrogen peroxide (the oxidation current proved proportional to the concentration of hydrogen peroxide). Gold films were found to be unsuitable for detecting hydrogen peroxide at neutral pH values but suitable for use in immobilizing cytochrome *c* and eventually developing a superoxide-specific electrode. Figures 6, table 1; references 11: 1 Russian, 10 Western.

Estonia: Stability of a Phenol-Sensitive Microbial Sensor

964D0236B Tallinn PROCEEDINGS OF THE ESTONIAN ACADEMY OF SCIENCES. CHEMISTRY in English Vol 44 No 2-3, Feb-Mar 95 pp 165-169

[Article by Kaja Orupold and Toomas Tenno, Institute of Physical Chemistry, University of Tartu; manuscript received 16 Mar 95; accepted 3 Apr 95]

[FBIS Summary] A phenol-sensitive microbial sensor was produced by immobilizing *Pseudomonas putida* EST1412 cells on an amperometric oxygen sensor. The oxygen sensor's polyethylene membrane was covered with a bacteria-agarose mixture, after which the bacteria-coated membrane was covered with an additional coating of 2-percent agarose gel. When not in use, the prepared sensors were held in 0.025 M phosphate buffer at 4°C. The sensor's steady-state responses to phenol in 0.025 M phosphate buffer (pH 6.9) solutions at 25°C were studied. The sensor's steady-state current was shown to depend on the concentration of phenol in the study solution. The sensor's response (δI) was expressed as the relative difference between the two steady-state currents, i.e., $(I_0 - I)/I_0$. When the microbial sensor was covered with the external agarose membrane, its response to phenol in a concentration of 0.116 mmol/l remained fairly constant over a period of 50 days (with a standard deviation of 1.2 percent). Further tests of the sensitivity and reproducibility of the results yielded by the sensor established that the external agarose membrane was essential. The new sensor was deemed promising for use in estimating the levels of phenol present in wastewater. Figures 4; references 6 (Western).

Estonia: Possibilities of Biodegradation of Phenol-Containing Wastes Originating From the Oil Shale Basin in Northeastern Estonia

964D0236C Tallinn PROCEEDINGS OF THE ESTONIAN ACADEMY OF SCIENCES. CHEMISTRY in English Vol 44 No 2-3, Feb-Mar 95 pp 185-193

[Article by Tiina Randla, Aleksei Rozkov, Arvo Kaard, and Raivo Vihi, Institute of Chemistry, Tallinn Technical University, Tallinn; manuscript received 16 Mar 95; accepted 21 Mar 95]

[FBIS Summary] Original and published data regarding the ecological situation existing in northeastern Estonia were reviewed. Wastewater originating from the region's chemical plants and containing phenols and other xenobiotic compounds was identified as the most critical ecological problem facing the region. The inadequately treated water discharged from the wastewater treatment plant of the Kiviter AS and water from the ash mounds of various chemical enterprises were deemed particularly trouble spots. The microflora present in the region's polluted water streams and soils was studied by creating a collection of microorganisms adapted to the region's conditions and studying their growth parameters on various substrates, including xenobiotics, at various temperatures, and with various concentrations of carbon source. Gram staining and various morphophysiological tests and microscopy studies revealed more than 20 bacterial strains in the water and soil samples analyzed. The strains isolated were determined to belong to the genera *Rhodococcus* and *Pseudomonas*. Strains of *Pseudomonas aeruginosa* were also identified. The growth rates of the various strains were determined by the streak plate method. The quantitative growth characteristics of the mesophilic strain of *Rhodococcus* sp. were determined by the A-state method of cultivation. Next, the feasibility of purifying the phenol-containing wastewater by using solid-state fermentation and immobilized cell bioreactors was studied in a series of experiments. A continuous solid-state fermentation system was developed. The preliminary study was performed with a batch of cultured *Rhodococcus* sp. in a thermostatted reactor with a mechanical stirrer. The reaction conditions were as follows: temperature, 30°C; pH, 6.9 +/- 0.2; initial moisture content, 11.2 percent; and initial content of substrate in the film of moisture covering the sand particles, 20 mM. The substrate was intensively utilized at the beginning of the cultivation process: the concentration of sodium benzoate decreased by a factor of 3.7 within 24 hours, and all of the substrate was utilized within 2 days. It was clear, however, that the process required further fine-tuning. Next, the feasibility of immobilization was examined in an experiment performed with cells of *Pseudomonas putida*. The reaction was performed at a temperature of 30°C and a pH of 6.8-7.0. The microorganisms were cultured in M9 mineral salt medium with a carbon source (2.5 mM sodium salt of benzoic acid or phenol in concentrations ranging from 2.5 to 10 mM). The inoculum was pregrown in M9 medium containing glucose and trace elements. Porous rubber with a density similar to that of water was found suitable for use in fluidized bed bioreactors. A fluidized bed column filled with 5 x 5 x 5-mm particles of porous rubber carrier was found to provide uniform distribution of the particles of carrier, good reliability,

and a low residual concentration of substrate. Table 1; references 29: 26 Russian, 3 Western.

Russia: Study of Properties of Ceramic and Sensors Based on Modified Indium Oxide

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[Article by N.Ye. Trofimenko, S.V. Baran, N.P. Masherova, and K.A. Lesnikovich, General and Inorganic Chemistry Institute, Byelarus Academy of Sciences, Minsk; manuscript received 10 Jan 95; UDC 541.183.6:539.21:53.087.9]

[FBIS Summary] Methods based on measuring adsorption and electrical conductivity were used to study the properties of a new ceramic and sensors based on modified indium oxide. Four new gas-sensitive ceramics were synthesized by the method of calcining at 850°C for 3 hours: The first new compound was obtained by calcining indium hydroxide, and the second was synthesized by calcining the basic salt obtained by treating $\text{In}(\text{OH})_3$ with nitric acid. The third compound, an Al_2O_3 -modified ceramic, was obtained from coprecipitated indium and aluminum hydroxides, and the fourth new compound was produced from a mixture of basic salts of the said hydroxides by treating them with nitric acid. In all cases, the concentration of Al_2O_3 ranged from 4 to 90 percent by weight. Sensors were formed from the new compounds as follows: Noncalcined samples of compounds 2 and 4 were applied onto a platinum microspiral (diameter of the wire, 0.02 mm; diameter of the turns, 0.4 mm), and an electric current was passed through the spiral. In response to the current, the turns of the spiral tightened to form a microcylinder. To stabilize their parameters and give them the required strength, the elements were calcined at 850°C. Attempts to manufacture sensors from the two hydroxides that had not been treated with nitric acid (compounds 1 and 3) proved unsuccessful. The difference between the sensors' voltage drop when stabilized current was fed through them in purified air and in methane-air mixtures with different methane concentrations was used as the sensors' output signal. The parameters of at least 10 sensors made of each of the two types of ceramic were measured. The concentration of Al_2O_3 added to the ceramic was found to significantly affect the study samples' gas sensitivity. Those sensors containing Al_2O_3 in a concentration of 4 to 5 percent by weight were the most sensitive in methane-air mixtures. The differences between the gas sensitivities of the different sensors were greatest during the detection of methane in low concentrations. In the case of a methane concentration of 0.01 percent by volume, the output signal of the sensor made from the modified ceramic was four times that of a sensor made

of pure indium oxide. Figures 3, table 1; references 6: 2 Russian, 4 Western.

Russia: Photo- and Electrochemical Properties of Partially Oxidized Polymer Complex of Cobalt With Bis(salicylidene)ethylenediamine

964D0274B St. Petersburg ZHURNAL PRIKLADNOY KHIMII in Russian Mar 95 Vol 68 No 3, pp 468-473

[Article by I.A. Orlova, A.M. Timonov, and G.A. Shagisultanova, St. Petersburg State Pedagogical University; manuscript received 29 Dec 94; UDC 547]

[FBIS Summary] A new method has been proposed for electrochemical synthesis of a new partially oxidized polymer complex based on a complex compound of cobalt (III) with bis(salicylidene)ethylenediamine. The azomethine base bis(salicylidene)ethylenediamine was produced by condensing chemically pure salicylaldehyde with ethylenediamine in ethanol. The lemon yellow crystals precipitated during the condensation reaction were filtered off, rinsed with hot water and ethanol, and dried in a dessicator at 70°C. The resultant product, which was produced in a yield of 95 percent, had a melting point of 123°C. Next, equimolar quantities of chemically pure anhydrous cobalt (II) chloride and freshly prepared bis(salicylidene)ethylenediamine were each dissolved separately in a small amount of ethanol while being heated and as argon was continuously pumped through the vessels holding the two compounds. The cold solution of CoCl_2 salt was poured into a graduated flask with the hot bis(salicylidene)ethylenediamine solution. A red-brown sediment formed immediately. The mixture was heated in a water bath for 30 minutes as inert gas continued to be pumped through. The resultant preparation was rinsed three times with hot ethanol, filtered, and dried in a vacuum evacuator over P_2O_5 . The reaction product was determined to contain the following (percent): Co, 18.1; C, 59; N, 8.6; and H, 4.24. Electrochemical studies of the new compound were conducted in a sealed three-electrode cell with a platinum electrode (99.99 percent platinum) with a surface area of 0.134 cm^2 serving as the working electrode and with a 0.1 M solution of tetraethylammonium perchlorate in acetonitrile serving as the background solution. All electrochemical measurements were taken with a PI-50-1 pulse potentiostat in potentiostatic and chronopotentiometric regimens with linear potential scanning at rates of 10 to 500/s with a PR-8 programmer. The starting 0.1 M solution of copper and bis(salicylidene)ethylenediamine was deaerated by bubbling dried argon through the working electrode space in the electrochemical cell. A special cell through which inert gas was passed and which contained a silver chloride as the reference electrode was used for

the photochemical studies. SF-20, SF-26, and Specord-UV-VIS spectrophotometers were used to record the study compound's optical absorption spectra. Two anode and two cathode waves within the interval of potentials from 0.00 to 1.20 V were evident on the new compound's potentiodynamic voltage-current curve. Attempts at the electropolymerization of a complex compound of cobalt and bis(salicylidene)ethylenediamine from propylenecarbonate and acetonitrile failed to yield satisfactory results. Polymerization was only achieved when an oxidized form of complex was used as the starting complex. Electrochemical accumulation of cobalt (III) in the reaction solution proved critical to a successful electropolymerization reaction, and the solvent used during the two-stage synthesis process was found to be exceptionally important to successful synthesis of the complex compound. The partially oxidized compound produced was characterized by a clear electrochromic effect and with an electrical conductivity, stability, and photosensitivity that are high for the given class of compounds. Figures 7; references 10: 4 Russian, 6 Western.

Russia: Developing a Method of Obtaining New Nutrient Solutions for Growing Microorganisms

964D0245A Moscow KHIMICHESKAYA PROMYSHLENNOST in Russian Apr 95 No 4, pp 222-224

[Article by A.G. Stepchenko, Moscow State Open University; UDC 678.562.002.237]

[FBIS Summary] The relatively new liquid three-component (complex) fertilizers that have been developed for use in agriculture are not suitable as nutrient solutions for growing microorganisms because they contain insoluble salts, toxic impurities (including fluorine and arsenic), and condensed (poly-) phosphates and because of their nutrient ratios. A new method of preparing nutrient solutions for growing microorganisms has therefore been developed. The new method does not entail the use of polyphosphoric acids, bypasses the intermediate stage of producing base solutions of liquid complex fertilizers, and uses high-speed tube reactor-type equipment. Scientists at the Nevinomysskiy Nitrogen Joint-Stock Company studied the possibility of developing a process for producing liquid potassium-ammonium phosphate ($\text{P}_2\text{O}_5 \cdot \text{K}_2\text{O} = 1.2$ to 3.2) and balanced solutions ($\text{P}_2\text{O}_5 \cdot \text{N} = 2.0$ to 2.6) based thereon. On the basis of wet-process phosphoric acid containing 54.6 to 58.5 percent P_2O_5 by weight, test batches of product were produced in a laboratory unit with a tube reactor. Phosphoric acid that had been heated to 80-107°C at a rate of 11.33 to 25.00 ml/min was fed into a tube reactor that had been preheated to 130-160°C. Ammonia gas was fed into the reactor

together with the acid. The gas was fed in straight from the tank without having been heated. In the tube reactor, the phosphoric acid was partially neutralized by the ammonia (the melt's pH was altered in range from 1.9 to 4.1) at a temperature of 180 to 271°C as the ratio and feed rate of the reagents were varied. The melt (a mixture of ammonium orthophosphates and polyphosphates) was passed into a final neutralizer to which a calculated amount of water and dry potassium hydroxide containing 85 percent KOH had first been added. In the experiments conducted to obtain balanced solutions, a calculated amount of carbamide containing 46.2 percent nitrogen was dissolved in the water before the start of the experiment. All of the test batches of product were transparent solutions. No sediment formed in any of the solutions even after storage at room temperature for 1 month and holding at 0°C for 3 days. All the samples met the requirements of the microbiology industry, had total nutrient concentrations of 28.60 to 43.67 percent, and had fluorine contents below 0.1 percent and arsenic contents below 0.75 percent mg/kg. Tables 2; references 8 (Russian).

Russia: Sonochemical Synthesis of Coordination Compounds of Hydrazonopodands With CuSO₄
964D0243A St. Petersburg ZHURNAL OBSHCHEY
KHIMII in Russian Apr 95 Vol 65 No 4, pp 655-656

[Article by O.V. Fedorova, I.G. Ovchinnikova, and G.L. Rusinov, Organic Synthesis Institute, Ural Department, Russian Academy of Sciences, Yekaterinburg; manuscript received 22 Dec 94; UDC 547.574.3:541.49]

[FBIS Summary] A series of experiments were conducted to optimize the process of synthesizing three coordination compounds of hydrazonopodands with copper sulfate: [1,2-bis(2-thiosemicarbazonomethylphenoxy)-ethane]copper (II) sulfate (compound 1); [1,5-bis(2-thiosemicarbazonomethylphenoxy)-3-oxapentane]copper (II) sulfate (compound 2); and [1,8-bis(2-thiosemicarbazonomethylphenoxy)-3,6-dioxooctane]copper (II) sulfate (compound 3). The three compounds were produced from three previously synthesized coordination compounds. First, the three compounds were synthesized in *o*-(2,4-dichlorophenyl)-*o*-methyl isopropylphosphoramidothioate [DMPA]; however, the process proved impracticable because the complex compound stubbornly retained the molecules of solvent. A series of experiments were therefore conducted to examine the feasibility of using ultrasound radiation in the synthesis process. The experiments established that the study reactions may be conducted in ethanol subjected to ultrasound radiation. When the starting components required to synthesize compound

1 were subjected to direct ultrasound treatment while in ethanol, the yield of compound 1 was relatively low, i.e., 52 percent after crystallization from DMPA. The best results were obtained when suspensions of each of the starting reagents in ethanol were first subjected to ultrasound treatment individually and then combined and subjected to ultrasound treatment once again. The resultant coordination compounds did not require additional purification and were synthesized in high yields (compounds 2 and 3 were synthesized in yields of 97 and 98 percent, respectively). Ultrasound treatment caused the reagents to disperse, which evidently increased and activated the surface of their solid phases. Especially interesting was the fact that the suspension of CuSO₄·5H₂O powder in ethanol changed from light blue to transparent after having been subjected to ultrasound treatment. The said color change was interpreted as evidence of the removal of water molecules from the copper cation's coordination sphere and replacement of the said molecules by molecules of solvent. After ultrasound treatment, the ligand suspension turned light yellow. The complex formation reaction was concluded to be a heterophase process characterized by a change in the solid phase's color from light yellow to yellow-green. The new compounds' compositions were confirmed by elemental analyses and ultraviolet and infrared spectroscopy. Table 1; references 6: 4 Russian, 2 Western.

Russia: Superoxide Dismutase Activity of Stable Nitroxyl Radicals

964D0243B St. Petersburg ZHURNAL OBSHCHEY
KHIMII in Russian Apr 95 Vol 65 No 4, pp 693-697

[Article by I.V. Shugaley, I.V. Tselinskiy, and Ye.Ye. Dubinina, St. Petersburg State Technological Institute; manuscript received 17 Jun 94; UDC 541.515:(547.741+547.82)]

[FBIS Summary] A study examined the superoxide dismutase [SOD] activity of the following four compounds: 4-azido-2,2,6,6-tetramethyl-1-piperidyloxy (I), 2,2,6,6-tetramethyl-4-cyclohexyliminomethyleneamino-1-piperidyloxy (II), 4-hydroxy-2,2,6,6-tetramethyl-1-piperidyloxy (III), and 3-isocyanato-2,2,5,5-tetramethyl-3-pyrroline-1-iloxy (IV). The four compounds' SOD activity was studied in a system generating O₂⁻ and containing phenazinemetasulfate and *n*-nitrotetrazolium blue. O₂⁻ was generated by reacting molecular oxygen with a phenazinemetasulfate radical. The course of the process was monitored by accumulation of the reduction product of *n*-nitrotetrazolium blue, namely, formazan blue. SOD activity was determined on the basis of the fact that SOD and SOD-like compounds reduce the rate at which formazan blue is

formed. Under standard conditions in the absence of nitroxyl radicals, the optical density of the control sample equaled 0.600 after 10 minutes. Adding stable nitroxyl radicals to the system in a concentration of 1.83×10^{-3} mol/l reduced the rate at which *n*-nitrotetrazolium blue was reduced. After 10 minutes under analogous conditions, the following optical density values were reached in the presence of the four study compounds: compound 1, 0.253; compound 2, 0.275; compound 3, 0.197; and compound 4, 0.481. The experiments thus demonstrated the nitroxyl radicals to have a distinct SOD-like activity. The SOD-like activity of the four study compounds under standard conditions was calculated as 1.28, 0.77, 2.13, and 0.25 arbitrary units/mg, respectively. SOD activity was therefore concluded to be clearly dependent on free radical structure: The effect of the study compounds decreased as the amount of substituent in the ring increased. In addition, the N-oxyl pyrrole derivative turned out to be significantly less active than the pyridine derivative. The said difference between the two compounds' level of activity was hypothesized to be due to differences in their acid-base properties. The study results were said to be consistent with published data. References 37: 20 Russian, 18 Western.

Russia: Photosensitive Polymers Based on Complex Compounds of Copper (II) and Palladium (II) With Bis(salicylidene)ethylenediamine

964D0273A St. Petersburg ZHURNAL PRIKLADNOY KHIMII in Russian Apr 95 Vol 68 No 4, pp 651-653

[Article by G.A. Shagisultanova, I.A. Orlova, and Yu.F. Batrakov, St. Petersburg State Pedagogical University; manuscript received 20 Dec 94; UDC 541.49]

[FBIS Summary] New data were obtained regarding the photochemical activity of polymers based on complex compounds of copper (II) and palladium (II) plus bis(salicylidene)ethylenediamine that were synthesized from acetonitrile solutions as follows: A platinum electrode with a surface area of 0.278 cm^2 was subjected to anode polarization in a 1×10^{-3} M solution of either copper (II) plus bis(salicylidene)ethylenediamine or palladium (II) plus bis(salicylidene)ethylenediamine at a potential of 1.1 V for 7 minutes. Next, the study electrode was transferred to a solution of background electrolyte (0.1 M tetraethyl ammonium chlorate in acetonitrile). The appearance of both cathode and anode waves on the curves recorded at potentiodynamic electrode polarizations of 0.0 to 1.2 V were taken as evidence of localization of the reduction-oxidation process in the solid phase. A comparison of the physicochemical parameters of the newly synthesized polymers with those of polymers of the same composition that were synthe-

sized with propylenecarbonate serving as the solvent established that using acetonitrile as the solvent results in polymers with significantly improved redox conduction and stability. The method of chemical shift of the polymers' hard x-ray lines was used to estimate the charge state of the metallic center of the oxidized form of polymer, the optical absorption spectra of their oxidized and reduced forms were recorded, and factors affecting the magnitude of their photo-induced potential (ΔE) were studied. A distinct electrochemical effect was observed as the potential of the platinum electrode with the complex polymer compounds was cycled in the said interval of potentials. When the potential was shifted to the positive region, the solid-phase products gradually turned blue-green in the case of the copper polymer and intense green in the case of the palladium electrode. When the potential-scanning direction was changed, the polychelate turned yellow in both cases. The increase and decrease of the potential of the two study systems in response to light were studied when samples of the two compounds were exposed to light for 15 seconds and after the luminous flux had been switched off. A significant change in electrode photopotential was observed that was attributed to the effect of light and a photo-stimulated process of electron transfer in the reduction-oxidation fragments of the polymer chain of the copper and palladium supramolecules. The maximum photopotential (350 mV) was obtained by irradiation of the reduced polymer film. Irradiation of the oxidized form of film resulted in a photopotential 15 percent lower than the peak value. When the thickness of the layer of palladium film (the reduced form) was reduced from 0.17 to $0.07 \mu\text{m}$ by decreasing the film-growth time to 3 minutes, the system's photopotential increased to 450 mV. The high photosensitivity of the new optically transparent polymers was emphasized. Figures 3, table 1; references 5 (Russian).

Russia: Immobilized Cholinesterase-Based Amperometric Biochemical Sensor in Immunoassay of Pesticides

964D0247A Moscow ZHURNAL ANALITICHESKOY KHIMII in Russian Jul 95 Vol 50 No 7, pp 782-786

[Article by E.P. Medyantseva, M.G. Vertlib, G.K. Budnikov, and S.S. Babkina, Chemistry Department, Kazan State University, Kazan, and S.A. Yereimin, Chemistry Department, Moscow State University, Moscow; manuscript received 24 Dec 93; UDC 543.253]

[FBIS Summary] A new highly selective and highly sensitive method of determining pesticide levels was developed by combining immunochemical reactions and a new immobilized cholinesterase-based amperometric sensor. The biosensitive portion of the new sensor was

produced by dissolving cellulose nitrate in a mixture of toluene and butylacetate and then adding an aqueous cholinesterase solution. After the mixture had been stirred, hexane was added as a coagulant. A coat of film of the resultant mixture was then applied to a glass surface and treated with a 5-percent solution of glutaric aldehyde. The area of the new sensor's working surface equaled $7.95 \pm 0.05 \text{ cm}^2$. When the sensor is to be used with an aqueous solution of antibodies, the film is first placed in a 1 percent aqueous solution of bovine serum albumin for 30 minutes to block the glutaric aldehyde's active centers and prevent nonspecific binding. The new sensor was used successfully to detect the pesticide 2,4-dichlorophenoxyacetic acid [2,4-D] in complex multicomponent mixtures in the presence of Zolone, glyphosate, Trichlormethaphos, and Thiodan when the 2,4-D was present in concentrations as low as $1 \times 10^{-11} \text{ mol/l}$. No more than 25 minutes was required for a single determination. The procedure to determine the concentration of 2,4-D in a test sample by means of the new sensor entails the following steps: A piece of nitrocellulose film with a surface area of $7.95 \pm 0.05 \text{ cm}^2$ and with antibodies encapsulated in it is placed in 5 ml of study solution and stirred for 5 minutes. The solution is then rinsed with distilled water and transferred to an electrochemical cell that already contains 4.5 ml of borate buffer solution with a pH of 9.05 and a saturated calomel electrode. The mixture in the electrochemical cell is then stirred for 5 minutes. Next, 0.5 ml of a butyrylthiocholine iodide solution with a concentration of 6 mg/ml is added to the cell, the biosensor is lowered in, and the oxygen is removed over the course of a 15-minute period by a stream of hydrogen. A PO-5122 polarograph (model 03) is then used to record the analytic signal in the interval of potentials from 0.1 to 0.9 V ($v = 1 \text{ V/s}$ with a regimen of continuous polarization and triangular potential scanning). The height of the cathode peak at a potential of -0.55 V is measured. The concentration of pesticide present in the sample is then determined based on a calibration graph of the dependence of the current in the peak on the negative value of the log of the concentration of pesticide. The determination error does not exceed 14 percent, and no more than 25 minutes is required for a single determination. Tables 3; references 18: 16 Russian, 2 Western.

Russia: Thermodynamics of Reactions of Coproportionation of Like Solvates of Samarium (III) and Yttrium (III) Nitrates With Neutral Organophosphorus Compounds

964D0261A St. Petersburg RADIOKHIMIYA
in Russian Vol 37 No 4, Jul-Aug 95 pp 351-353

[Article by A.K. Pyartman, St. Petersburg Technological Institute; manuscript received 20 Feb 95; UDC 541.11:542.65:541.49]

[FBIS Summary] The thermal method was used to measure the heat of reactions of coproportionation of like solvates of samarium (III) and yttrium (III) nitrates with the following neutral organophosphorus compounds at 298.15 K in hexane: tri-*n*-butylphosphate, diisooctylmethylphosphonate, and diisoamylmethylphosphonate. The solutions of solvates of the samarium (III) and yttrium (III) nitrates were prepared by 100-percent saturation of the three neutral organophosphorus compounds with the rare earth metal nitrates. Solutions with the required concentrations were obtained by diluting the starting solutions of solvates with hexane. The thermodynamic studies were conducted on a calorimeter with an isothermal jacket at 298.15 K with a thermostating precision of 0.001-0.002 K. The thermometric circuit had a sensitivity of 3.22 J/cm of the scale of the KSP-4 automatic recorder used in the experiments. The calorimeter was calibrated by heating with an electric current and based on the heat required to neutralize 0.1 mol/dm³ of hydrochloric acid solution with a 0.1 mol/dm³ solution of sodium hydroxide. The enthalpy of the neutralization reaction equaled $-56.06 \pm 0.12 \text{ kJ/mol}$. The experiments established that the enthalpies of the coproportionation reactions all equaled $-1.1 \pm 0.2 \text{ kJ/mol}$ and were all virtually independent of the nature and concentration of the solvates of the rare earth metal (III) nitrates in hexane and the nature of the neutral organophosphorus compound. The free Gibbs energy of coproportionation was found to equal -5.43 kJ/mol , and their entropy was determined to equal $14.5 \pm 0.7 \text{ J/(mol} \times \text{K)}$. Table 1; references 8 (Russian).

Russia: Coprecipitation of ^{152}Eu With Ferric Hydroxide Formed During the Reduction of Sodium Ferrate (VI) in an Aqueous Medium
964D0261B St. Petersburg RADIOKHIMIYA
in Russian Vol 37 No 4, Jul-Aug 95 pp 359-365

[Article by D.Yu. Stupin, St. Petersburg State Agrarian University, and M.I. Ozernoy, scientific-assimilation firm Analytic Systems; manuscript received 12 Dec 94; UDC 546.661:546.726]

[FBIS Summary] The coprecipitation of ^{152}Eu with ferric hydroxide formed during the reduction of sodium ferrate (VI) in an aqueous medium was examined. The primary objective of the study was to compare the levels of sorption of ^{152}Eu on two types of ferric hydroxide, namely, ferric hydroxide formed during the hydrolysis of $\text{Fe}_2(\text{SO}_4)_3$ and ferric hydroxide formed during spontaneous decomposition in a solution of sodium ferrate (VI). The Fe(III) was precipitated from solutions with an ionic strength of 1 created by a background electrolyte (a 1-mol/l NaNO_3 solution). The sodium ferrate (VI) was synthesized at 643 K in a solid-phase reaction between stoichiometric quantities of sodium peroxide and iron (III) oxide in a stream of dry oxygen that had been purified of CO_2 . The resultant solutions had a red-violet coloration analogous to that of a K_2FeO_4 solution, and their absorption spectrum was identical to that of K_2FeO_4 . The pH of the solution, the amounts of iron (III) ferrate and sulfate added to it, and the oxalate ion were varied during the experiments. Two analogous series of solutions with 18 samples in each series were prepared. The pH of the solutions ranged from 2.5 to 12. The starting ^{152}Eu solution had a pH of 1.9 and contained an unknown quantity of carrier. Its pH was brought to 7 by adding 0.1 mol/l NaOH . After 2-3 days, the sediment was filtered out, and the filtrate was used in the experiments. A Robotron 20050 spectrometer with a crystal detector and relative measurement error of 1 to 4.5 percent was used to measure the radioactivity of the samples, the background radiation, and the radioactivity of the standard. In the experiments, Fe was added in two concentrations: 245 and 1.2 mg/l. Regardless of which of the two methods was used to form the Fe(III) hydroxide, as the pH of the solution rose from 6 to 11.5, the Eu underwent a virtually complete transition to the solid phase, even when the amount of iron in the solution was reduced by a factor of 200. Nevertheless, at low concentrations of Fe(III) , the level of coprecipitation with the hydroxide formed from the ferrate was somewhat greater (3-5 percent). At pH levels in the interval from 2.5 to 5.5, the Eu extraction process involving the second of the two methods of forming the hydroxide, i.e., that of spontaneous reduction of

sodium ferrate (VI) as the pH of the solution rose, was significantly more effective than the process based on hydrolysis of Fe(III) sulfate. The superiority of the process based on spontaneous reduction of sodium ferrate (VI) was especially evident at low concentrations of Fe(III) in the solution (approximately 1.2 mg/l or 2.2×10^{-5} mol/l) and was attributed to the fact that it resulted in a hydroxide with a better-developed surface and hence more sorption centers on its surface. Adding oxalate ions to the solution (in a concentration of 6.7×10^{-4} mol/l) impeded coprecipitation of Eu^{3+} ; however, the ferrate ion easily oxidized the oxalate, which in turn made the procedure based on using hydroxide formed by spontaneous reduction even more effective than the procedure involving hydroxide formed by hydrolysis of Fe(III) sulfate. Preliminary data regarding the coprecipitation of ^{242}Pu and ^{241}Am with Fe(III) hydroxide that had been formed from sodium ferrate (VI) was also presented. The experiments were said to give reason to hope that sodium ferrate, which boasts an oxidation power surpassed only by that of ozone and which is one of the best coagulants, will prove suitable for use in processes for cleaning liquid radioactive wastes. Figures 2, table 1; references 7: 4 Russian, 3 Western.

Russia: New Approach to Synthesizing Immobilized Stationary Phases for Capillary Gas Chromatography

964D0235A Moscow ZHURNAL ANALITICHESKOY
KHIMII in Russian Sep 95 Vol 50 No 9, pp 961-964

[Article by V.P. Mukhina, Ya.A. Levin, V.G. Berezkin, and R.M. Mukhamadeyeva, Organic and Physical Chemistry Institute imeni A.Ye. Arbutov, Kazan Research Center, Russian Academy of Sciences, Kazan; manuscript received 13 Jan 94; UDC 543.544]

[FBIS Summary] A series of experiments were performed to develop a new approach to synthesizing immobilized stationary phases for capillary gas chromatography. Pyrex capillary columns (23.0 m x 0.27 mm and 25.0 m x 0.30 mm) were filled with a polyol (polyglycidol) immobilized stationary phase with a film thickness of 0.35 and 0.51 μm . The stationary phase was then oxidized with concentrated HNO_3 ($\rho = 1.507 \text{ g/cm}^3$) at room temperature under static and dynamic conditions. In the experiments conducted under static thermodynamics, the column was filled with acid in the usual manner at a meniscus rate of 5-7 cm/s. After 30-90 minutes, the acid was removed and the column was rinsed successively with 4 ml of diluted HNO_3 and twice-distilled water until a neutral reaction was achieved. Next, the column was dried for approximately 1 hour by blowing inert gas into the column's entrance with a pressure of

approximately 0.5 MPa. In the experiments performed under dynamic thermodynamics, the acid used for the oxidation was forced forward and backward through the column at a meniscus rate of 2 cm/s. The columns prepared in both manners were placed into the thermostated chamber of a chromatograph and conditioned by heating from 20 to 120°C at a rate of 3°/min and then holding the columns at 120°C for 1 hour. The stationary phase's functional selectivity was estimated by determining the Kovac retention indices of the first five Max Reynolds sorbates: benzene, butanol, pentanone-2, 1-nitropropane, and pyridine. The values of the column's theoretical plate equivalent height and capacity factor were calculated with respect to the naphthalene peak at 100°C. Modification of the immobilized polyol for 30-90 minutes under both static and dynamic thermodynamics resulted in the appearance of intensive absorption bands in the stationary phase's infrared spectrum around 1640, 1289, and 860 cm⁻¹. The said frequencies are characteristic for the vibrations $\nu(\text{NO}_2)$, $\nu(\text{NO})$, and $\nu(\text{N-OC})$, respectively, and thus confirm that ONO_2 fragments are present in the structure of the nitrate phases. It was impossible to determine unequivocally from the spectra of films of stationary phase with a thickness of 0.35 to 0.51 μm whether carbonyl, carboxyl, or ketone groups formed. Acid treatment of the immobilized polyol weakened its proton donor properties but significantly increased the capillary columns' efficiency and capacity. The main effect of nitric acid on the immobilized polyol under the study conditions was thus one of esterification (nitration) of the stationary phase's hydroxyl groups. The experiments performed were the first to demonstrate the possibility of chemical modification of capillary columns with an immobilized functionally selective stationary phase. Figures 5; references 14: 8 Russian, 6 Western.

Russia: Rapid Immunochemical Method of Detecting the Herbicide Methabenzthiazuron

964D0235B Moscow ZHURNAL ANALITICHESKOY KHMII in Russian Sep 95 Vol 50 No 9, pp 971-978

[Article by S.A. Yeregin and O.A. Melnichenko, Chemistry Department, Moscow State University imeni M.V. Lomonosov, Moscow, and S. Kreysig and B. Khok, Botany Department, Technical University of Munich, Weihenstephan, Germany; manuscript received 4 May 94; UDC 57.083.3;535.518;547.588]

[FBIS Summary] A rapid immunochemical method of detecting the herbicide methabenzthiazuron was developed, and the effect of the analytic system of organic solvents frequently used to prepare actual test samples on the new method was examined in a series of experiments. The new method, which is based on the technique of nonseparation polarization fluorescence immunoassay, is performed as follows: A sample of 20 μl of the solution to be analyzed is placed in a vial. First, 500 μl of marker solution is added to the sample in a concentration of 10 nmol/l. Next, 500 μl of binding reagent in an 1,800x dilution is added. Ten such vials are loaded into a special carousel that is then placed into a TD₂ semiautomatic polarization fluorimeter (Abbott, United States). The fluorescence polarization values are calculated, and the results are printed out within 7 minutes. The entire analysis process requires only 10 minutes and permits semiautomated detection of methabenzthiazuron in concentrations of 0.02-5 $\mu\text{g}/\text{mg}$. When $n = 3$, the new herbicide detection method has a relative standard deviation no higher than 16 percent. Neither benzthiazuron present in a 20-fold excess and nor the herbicides ethidimuron, isoproturon, diuron, cotolan, thidiazuron, 2,4-D, 2,4,5-T, and DDT in greater than 100-fold excesses interfered with the detection of methabenzthiazuron by the proposed method. In tests based on the "added-found" method, the new detection method detected between 96 \pm 8 percent and 102 \pm 6 percent of the methabenzthiazuron present in the samples with $s_r < 0.08$. The new nonseparation polarization fluoroimmunoassay method was been recommended for monitoring methabenzthiazuron in bodies of water intended for industrial and household use. Figures 2, tables 5; references 25: 13 Russian, 12 Western.

Russia: Altering Selectivity of Potentiometric Analysis Methods

964D0235C Moscow ZHURNAL ANALITICHESKOY KHMII in Russian Sep 95 Vol 50 No 9, pp 965-970

[Article by B.P. Nikolskiy (deceased), Evolutionary Physiology and Biochemistry Institute imeni I.M. Sechenov, Russian Academy of Sciences, St. Petersburg, and Ye.B. Nikolskaya, Kazan State University, Kazan; manuscript received 29 Mar 94; UDC 543.257.1]

[FBIS Summary] Publications examining the main techniques for altering the selectivity of potentiometric analysis methods by modifying the ion-selective electrode (the sensor in potentiometric analysis methods) and the conditions under which the analysis is performed were reviewed. Special attention was paid to publications discussing the use of intermediate reactions occurring in the study solution or in a biospecific membrane to form or annihilate the potential-determining substance. Among the review's main conclusions were the following: Altering the potentiometric sensor's selectivity requires changing the composition of the active electrode membrane of the ion-selective electrode or the material from which the sensor has been manufactured, as has

been reported in several publications. Yet other publications have demonstrated that a potentiometric sensor's selectivity may also be altered by adding an additional membrane to separate the basic study solution from the electrode's surface. The idea of using "separating" membranes may be traced to the practice of using "dialysis" membranes to protect an indicator electrode's surface from the effects of surfactants, proteins, and other high-molecular-weight compounds. Membranes with a high sorption capacity may, for example, protect an electrode's surface from those interfering materials that the "sorption" membranes are capable of absorbing. Potentiometric sensors may be rendered selectively sensitive to gases or volatile materials by separating a solution undergoing analysis from an electrode's surface by using gas-permeable membranes or a gas gap, and biospecific membranes make it possible to determine many biologically active materials by using potentiometric methods. Another way of boosting the selectivity of potentiometric analysis methods is to modify the conditions under which the analysis is conducted, the process temperature, and the composition of the study solution. A classic example of the said approach is potentiometric titration, during the process of which a reaction occurs that causes the disappearance or appearance of potential-determining ions. Biospecific potentiometric analysis methods are analogous to the potentiometric titration approach. Immobilizing biopreparations on the surface of working electrodes has made it possible to create biosensors. The selectivity of biopotentiometric methods depends on the nature of the bioreagent, the method used to mobilize and/or modify it, and the conditions of the biospecific reaction. Bioreagents (including enzymes) make it possible to use one and the same working electrode to develop a multitude of methods with the most diverse selectivities. Depending on the enzyme used, biopotentiometric methods may be developed to detect individual substances (including stereoisomers), estimate levels of enzyme activity, and detect effectors (i.e., substance affecting the course of biospecific reactions). Biosensors' selectivity may be significantly altered by modifying the conditions of the enzyme reaction of the enzyme source and the method used to immobilize the enzyme. Biopotentiometry using living microorganisms has proved very interesting. Potentiometric methods based on gas-sensitive sensors that are in turn based on a pH-metric electrode have been developed to determine the following: NH_4^+ ions, NH_3 , total nitrogen (organic and inorganic), urea, amino acids, monoamines, NO_2^- ions, NO_3^- , SO_3^{2-} ions, SO_4^{2-} , S^{2-} ions, H_2S , total sulfur carbonates, CO_3 , and total carbon. In many cases, several techniques for boosting the selectivity of potentiometric detection must be used simultaneously. In addition, multienzyme sensors have signifi-

cantly expanded the range of detectable concentrations of substances and improved the selectivity of the potentiometric analysis procedure. For example, Table 1; references 60: 38 Russian, 22 Western.

Russia: Magnetothermoelectric Properties of Extruded Samples of Lead-Alloyed Solid Solution of $\text{Bi}_{1-x}\text{Sb}_x$

964D0248A Moscow NEORGANICHESKIYE MATERIALY in Russian Nov 95
Vol 31 No 11, pp 1405-1407

[Article by M.M. Tagiyev and D.Sh. Abdinov, Photoelectronics Scientific Research Institute, Azerbaijan Academy of Sciences, Baku; manuscript received 26 Apr 94; UDC 621.315.592]

[FBIS Summary] Solid solutions of the system Bi-Sb are promising materials for low-temperature thermoelements. A series of experiments were therefore performed to determine the effect of lead impurities on the electrical conductivity (σ) and thermoelectromotive force (α) and Hall (R_H) coefficients of extruded samples of the solid solution $\text{Bi}_{1-x}\text{Sb}_x$ at temperatures in the interval from approximately 80 K to approximately 300 K and magnetic field intensities up to approximately 64×10^4 A/m. The $\text{Bi}_{1-x}\text{Sb}_x$ was synthesized from type Bi-000 antimony and Su-0000 antimony. The synthesis process was performed in quartz vials that had been evacuated to approximately 10^{-3} Pa. The resultant alloy was ground, pressed into bars, and extruded in the form of finely dispersed billets. Study samples with a low concentration of lead were produced by melting billets containing lead in a concentration of 0.1 atomic percent with nonalloyed billets. The synthesis process was conducted at approximately 675 K for 2 hours. All electrical measurements were taken by the conventional compensation method under direct current along the samples' extrusion axis. The magnetic field affected the alloyed and nonalloyed samples differently: in the case of the $\text{Bi}_{1-x}\text{Sb}_x$ samples alloyed with 0.01 atomic percent lead, the sign of α in the absence of a magnetic field and the sign of R_H in the presence of magnetic fields up to approximately 9.6×10^4 A/m were negative. As the intensity of the magnetic field increased, both α and R_H changed from negative to positive after the magnetic field intensity reached approximately 9.6×10^4 and 24×10^4 A/m, respectively. In the case of samples containing lead in a concentration of 0.05 atomic percent, both α and R_H were positive both during the absence of a magnetic field and in the presence of a magnetic field throughout the entire range of field intensities studied. At temperatures above approximately 200 K, the sign and nature of the dependences of α and R_H on magnetic field intensity corresponded to the analogous dependences for the nonalloyed sam-

ple. It was concluded that the lead atoms create acceptor centers in $\text{Bi}_{1-x}\text{Sb}_x$ and that the said centers compensate for the donor centers, thereby causing a decrease in the concentration of electrons in the conduction band and thus causing a sharp decrease in σ as the concentration of lead increases. Thus samples of $\text{Bi}_{1-x}\text{Sb}_x$ alloyed with lead in concentrations of 0.05 atomic percent or more were determined to have p -type conductivity. Figures 4; references 4: 3 Russian, 1 Western.

Russia: Structure and Magnetic Properties of Quick-Hardening Foil of the System Mn-Bi

964D0248B Moscow NEORGANICHESKIYE MATERIALY in Russian Nov 95
Vol 31 No 11, pp 1426-1430

[Article by V.V. Vlasov, S.V. Gusakova, S.V. Sukhvalo, and V.G. Shepelevich, Belarus State University, Minsk, 25 Jul 94; manuscript received 25 Jul 94; UDC 538.221.621.786.68]

[FBIS Summary] A study examined the structure and magnetic properties of Mn-Bi foils produced by splat cooling from a melt with a temperature of $1,175 \pm 25$ K. The Mn-Bi foils were produced by crystallizing a drop of melt on the inner polished surface of a copper cylinder that was rotating at a rate of 50 rotations per second. The temperature in the working space of the melting furnace was monitored by a thermocouple and kept between 1,250 and 1,200 K. Foils with a thickness of approximately 50 μm were used. The cooling rate equaled approximately 10^6 K/s. The manganese-bismuth alloys were prepared from pure bismuth (99.99 percent pure) and electrolytic manganese (99.9 percent pure) in various proportions (the concentration of Mn ranged from 20 to 50 atomic percent). The structure of the study foils was determined by metallographic (with an MMU-3 microscope), x-ray spectral microanalysis (with an REMMA-100U unit and beam-accelerating voltage of 30 kV), and x-ray analysis (with a DRON-2 diffractometer). The foils' magnetic properties were studied with an automated vibromagnetometer. Analysis of the diffraction peaks in the study foils' diffractograms established that the starting foil contained bismuth and MnBi in a hardened high-temperature phase with an NiAs-type lattice. The lattice parameters ($c = 5.87$ and $a = 4.38$ angstroms) determined for the study samples were consistent with values reported elsewhere. Weak MnO lines were also found in the samples' roentgenograms. The metallographic analysis established the foils to have a Bi matrix with an MnBi phase present in the form of inclusions ranging from 5 to 10 μm in size. The hardened high-temperature MnBi phase proved rather stable at room temperature. It underwent a phase transition to a low-temperature phase at 453 K. The phase transition

was accompanied by an abrupt change in lattice parameters without any change in the type of structure. Further analysis of the samples' diffraction peaks revealed that the amount of hardened high-temperature phase present in the samples decreased upon aging at room temperature. At room temperature, restructuring of the samples culminates in 350-450 hours, with the rate of the phase transformation from a hardened high-temperature phase to a low-temperature phase increasing as the temperature is increased. In the case of isochronous annealing with the temperature being raised in 25-degree increments and with 20 minutes spent at each temperature, the phase transition culminated at 400 K. Studies of the structural transformations occurring in foils produced by splat-cooling with a temperature of 1,175 K established the said MnBi compound to be a hardened high-temperature phase that was much less stable than the same phase produced by hardening the high-temperature phase. On the other hand, lowering the temperature of the Mn-Bi melt from 1,473 to 1,175 K resulted in a decrease in amorphism and the formation of finely dispersed unstable hardened high-temperature phase. The annealed quick-hardened Mn-Bi foils were characterized by a high coercive force. Figures 4, table 1; references 13: 3 Russian, 10 Western.

Russia: Physicochemical Properties of $(\text{Bi}_{1-x}\text{Pb}_x)_1\text{Y}_y\text{O}_{1.5}$ ($y = 0$ to 0.25 and $x = 0.10$ and 0.32) Ionic Conductors

964D0248C Moscow NEORGANICHESKIYE MATERIALY in Russian Nov 95
Vol 31 No 11, pp 1465-1469

[Article by Ye.N. Naumovich, V.V. Kharton, S.A. Skilkov, and V.V. Samokhval, Byelarus State University, and Physicochemical Chemical Problems Scientific Research Institute, Minsk; manuscript received 8 Nov 94; UDC 541.11]

[FBIS Summary] The physicochemical properties of $(\text{Bi}_{1-x}\text{Pb}_x)_1\text{Y}_y\text{O}_{1.5}$ ($y = 0$ to 0.25 and $x = 0.10$ and 0.32) ionic conductors were examined. The synthesis method used was a method that had previously been used successfully to produce solid solutions of the systems $\text{Bi}_2\text{O}_3\text{-ZrO}_2\text{-Y}_2\text{O}_3$ and $\text{Bi}_2\text{O}_3\text{-Co}_3\text{O}_4\text{-Y}_2\text{O}_3$. The method called for adding the least soluble component of the ternary solid solutions to the bismuth oxide first. Polycrystalline samples of $(\text{Bi}_{1-x}\text{Pb}_x)_1\text{Y}_y\text{O}_{1.5}$ were produced in two stages in accordance with the standard ceramic process: In stage 1, bismuth and lead oxides were taken in the required ratio and sintered in air at 820-1,020 K for a total of 20 hours. In stage 2, calculated quantities of yttrium nitrate were added to the $\text{Bi}_{0.9}\text{Pb}_{0.1}\text{O}_{1.5}$ and $\text{Bi}_{0.68}\text{Pb}_{0.32}\text{O}_{1.5}$ powders produced in stage 1, and the mixture was annealed in air at

820-1,120 K for a total of 15-25 hours. Ceramic samples in the form of 4 x 4 x 30-mm bars and 7.5-mm-diameter tablets (with a thickness of 1-2 mm) were shaped by hydraulic pressing and sintered in air for 10-25 hours at temperatures 20-50 K higher than the synthesis temperature. The study samples were subjected to roentgenographic, x-ray spectral, and dilatometric analysis; their electrical conductivity was measured; and they were subjected to differential thermal analysis and thermogravimetric analysis in air at temperatures from 300 to 900 K with an OD-102 MOM thermal analyzer. The studies established that the study samples characterized by the formula $(\text{Bi}_{1-x}\text{Pb}_x)_{1-y}\text{Y}_y\text{O}_{1.5}$, where $y > 0.15$ were solid solutions of $\delta\text{-Bi}_2\text{O}_3$ with a face-centered crystal structure. The complex oxides described by the same formula but with $y \geq 0.15$ were characterized by the presence of a second phase, namely, isostructural $\gamma\text{-Bi}_2\text{O}_3$. The phase composition of the $(\text{Bi}_{0.98}\text{Pb}_{0.02})_{1-y}\text{Y}_y\text{O}_{1.5}$ composites was found to be thermodynamically stable at temperatures between 300 and 700 K and that of $(\text{Bi}_{0.90}\text{Pb}_{0.10})_{1-y}$ was found to be thermodynamically stable at temperatures below 600 K. It was further discovered that at temperatures between 700 and 950 K, the ionic conduction of $(\text{Bi}_{0.90}\text{Pb}_{0.10})_{1-y}$, far exceeds its electron conduction. The measured values of its oxygen transport numbers $[t_o]$ equaled at

least 0.90 ± 0.02 at temperatures above 850 K and at least 0.86 ± 0.03 for temperatures from 700 to 850 K. The the ion transfer number values recorded for the $(\text{Bi}_{0.98}\text{Pb}_{0.02})_{1-y}\text{Y}_y\text{O}_{1.5}$ solid solutions at temperatures between 700 and 820 K lay in the interval $0.84\text{--}0.95 \pm 0.03$. The amount of the second phase present in the samples increased as the concentration of yttrium was decreased. The experiments thus established that simultaneous stabilization of $\delta\text{-Bi}_2\text{O}_3$ with lead and yttrium oxides makes it possible to produce materials with predominately oxygen ion conduction that, at high temperatures, significantly exceeds the conduction of the most conductive solid electrolytes of the system $\text{Bi}_2\text{O}_3\text{--Y}_2\text{O}_3$. Figures 2, table 1; references 10: 4 Russian, 6 Western.

Russia: Magnetite Colloid With High Magnetic Susceptibility

964D0246A Moscow KOLLOIDNYY ZHURNAL
in Russian Vol 57 No 6, Nov-Dec 95 pp 844-848

[Article by A.F. Pshenichnikov and A.V. Lebedev, Continuum Mechanics Institute, Ural Department, Russian Academy of Sciences, Perm; manuscript received 20 Jul 95; UDC 541.18]

[FBIS Summary] A new magnetite ferrocolloid with a high initial magnetic susceptibility was produced under laboratory conditions by the standard method of chemical precipitation. The colloid had a saturation induction of $M_0 = 56.9$ kA/m and an initial magnetic susceptibility of $\chi_0 = 5.72$. The colloid was divided into several parts, and different amounts of isopropyl alcohol were added to each. All the solutions were carefully mixed and held at room temperature for 2 days. Under the effect of the isopropyl alcohol, a portion of the colloid particles coagulated and were precipitated out of the solution in the form of a sediment. The particles remaining in the solution retained their sedimentation resistance but were possibly also aggregated to a certain extent. A sample of the coagulation-resistant colloid fraction located near the top of the test tube was used to measure the said fraction's initial susceptibility. An analysis of the curve plotted for the dependence of the study samples' magnetic susceptibility on the volume concentration of isopropyl alcohol established that as the concentration of isopropyl alcohol increases, the initial susceptibility of the colloid decreases monotonically without any threshold effects, although in the range of isopropyl alcohol concentrations from 20 to 30 percent, the rate of coagulation is significantly higher than in other segments of the curve plotted. The even change in initial susceptibility as the concentration of isopropyl alcohol is increased was interpreted as a natural result of the polydisperse nature of the particles. In view of that fact, a solution of the sediment was prepared that consisted of 100 ml of the starting liquid and 25 ml of isopropyl alcohol. The sediment (colloidal magnetite with a elevated concentration of large Brownian particles) was rinsed with acetone and repeatedly peptized in kerosene. The resultant sample of magnetite fluid had an initial susceptibility of 35.0 (and a saturation induction of 89.9 kA/m), which was six times higher than that of the starting solution. Next, the isopropyl alcohol was removed from the stable part of the solution. The resultant sample, which had a relatively low concentration of large particles, had an initial susceptibility of 3.85 (and a saturation induction of 54.5). The frequency curve of the magnetite colloids dynamic susceptibility was found to have a quasi-Debye form with an elevated scatter in the vicinity of frequencies on the order of 10^3 Hz. A comparison of the results obtained in the experiments with those obtained by theoretical calculation indicated that existing theoretical models are inadequate for quantitative description of the temperature dependence of initial susceptibility and must therefore be corrected. Figures 3, table 1; references 26: 19 Russian, 7 Western.

**Russia: Laser Scanning Polarimeter-Based
Computer Phase Microscope**

964D0246B Moscow KOLLOIDNYY ZHURNAL
in Russian Vol 57 No 6, Nov-Dec 95 pp 906-908

[Article by M.V. Valeyko, R.I. Kononov, A.Ya. Perlov, and A.Yu. Toporov, AOZT (not further identified) firm Lal; manuscript received 21 Dec 94; UDC 681.723]

[FBIS Summary] A new, relatively simple laser scanning polarimeter-based computer phase microscope has been developed that makes it possible to observe microobjects on the screen of a personal computer, fix the dimensions of observed objects in a computer's memory, and computer-process images of objects. The main components and principles of operation of the new computer phase microscope are as follows: A plane-polarized light beam from a helium-neon laser with a wavelength of $0.63 \mu\text{m}$ passes successively through a quarter-wave wafer that transforms linear polarization into circular polarization, a beam expander, a spatial filter, and a beam splitter and falls onto the mirror of a horizontal-scanning scanner. The laser beam is reflected from the mirror through a telescope (with a magnification of 1) and falls onto the mirror of a vertical-scanning scanner. After having been reflected from vertical scanner and passing through a telescope (with a magnification of 6), a birefringent beam splitter, and a lens, the beam falls onto an object (i.e., a plane surface with a high reflectivity onto which some study sample, such as powder particles, liquid drops, or suspensions, are placed). The light reflected from the object's surface passes back through the optical system and is directed by a beam splitter to a differential (balance) photoreceiver. The photoreceiver consists of a Wollaston polarization prism that splits the incident beam into two beams with orthogonal polarization and two FD-24K photodiodes that are connected in a differential circuit. The differential photoreceiver's components are all mounted in a single metal case. The photoresponse signal is amplified, digitized by an L-202 interface board (the Russian analogue of a LabMaster that is assembled on the basis of an 1108 PV2 analog-digital converter), and processed by an IBM PC/AT 386. The optics used in the new computer phase microscope make it possible to observe objects with dimensions ranging from 0.8 to $200 \mu\text{m}$, and computer programs have been developed for use with the new microscope that make it possible to determine the distribution of observed objects in 10 size ranges. The capabilities of the new instrument's optical train may be significantly improved and its cost may be significantly reduced by using scanning devices with a deviation angle on the order of $\pm 10^\circ$ and by using wide-aperture and short-focus lenses. Figures 3; references 8: 6 Russian, 2 Western.

Russia: Structural, Selective Properties of a New Type of Porous Media—Punch-Track Membranes and Filters

964D0246C Moscow KOLLOIDNYY ZHURNAL
in Russian Vol 57 No 6, Nov-Dec 95 pp 912-914

[Article by A.N. Yevdokimov, A.G. Kirillov, V.A. Smirnov, D.L. Zagorskiy, and B.V. Mchedlishvili, Crystallography Institute, Russian Academy of Sciences, Moscow; manuscript received 15 Oct 94; UDC 66.067.38.021.039]

[FBIS Summary] A new type of porous medium has been developed, and its structural properties and selectivity have been examined. The new porous media, which have been tentatively called punch-track membranes and filters, are in essence continuous systems whose pores are formed in the initial stage by puncture of the starting nonporous polymer or metal films by microstrikers of colloidal dimensions. Pores (both through and surface pores) are formed in the polymer/metal film material as a result of the impact of a high-energy flow of microparticles traveling at velocities of 7 to 9 km/s. The punch-track membranes and filters

studied were made of polytetrafluoroethylene (F-4), aluminum, copper, stainless steel, titanium, tantalum, and tungsten. The thickness of the starting films ranged from 10 to 100 μm . The punch-track membranes and filters' structure was studied with a TESLA BS-340 electron microscope, and their pore sizes were estimated by hydrodynamic methods. The selectivity of the new punch-track membranes and filters was determined by filtration of 0.002 to 0.5 percent suspensions of calibrated polystyrene latex particles with diameters of 0.5 and 1.0 μm , corundum microspheres with diameters ranging from 0.5 to 2.0 μm , and porous silica gel with particle diameters ranging from 5 to 50 μm . The concentration of microparticles before and after filtration by the new punch-track membranes and filters was determined by counting the particles under an electron microscopy and by the spectroturbidimetric method. The pores formed in the new punch-track membranes and filters ranged from 1 to 100 μm in diameter and corresponded to the dimensions of the microstrikers used. The porosity of the resultant punch-track membranes and filters ranged from 3 to 10 percent. Figures 4; references 5: 4 Russian, 1 Western.

Russia: Calculated Model of Global Carbon Circulation

964D0288A Moscow *ENERGETIKA* in Russian
No 5, Sep-Oct 95 pp 3-15

[Article by K. S. Demirchyan, K. K. Demirchyan; UDC
631.3 (manuscript received 15 Jun 95)]

[FBIS Summary] A set of functional links is proposed which makes it possible to study the global carbon cycle. Formulas and numerical coefficients are presented which enable one to functionally describe the relation between human population, total carbon emissions, and CO₂ drains into the atmosphere, the ocean, and biosphere. Carbon circulation of anthropogenic origin is separated from natural carbons circulation. Changes in the intensity of solar radiation and biospheric reactions to natural CO₂-producing processes are considered.

The change in atmospheric CO₂ concentration due to oceans (absorption and release of CO₂, a temperature-dependent process) is considered. The concentration of anthropogenic CO₂ in the atmosphere is linked with human population by a near linear function. Divergence from the linear function is attributed to major volcanic eruptions, and data to support this are presented. Periods between ice ages and transitional periods are considered separately. Problems in estimating changes in human population are addressed. The formulas developed here make it possible to functionally describe the pattern of change in atmospheric CO₂ concentration and calculate it using a common pocket programmable calculator. While they provide a rough approximation, it is a rather realistic representation of the most significant factors of carbon circulation. Figures 8; tables 5; references 10: 4 Russian, 6 Western.

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